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Manpower Planning: A Case Study of the Systems Group, Alberta Government Services

by

© Helen M. Cox

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Business Administration

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EDMONTON, ALBERTA

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ABSTRACT

The Systems Group of Alberta Government Services (a department of the provincial government of Alberta) is responsible for the management and delivery of electronic data processing services to other provincial government departments. One of the greatest constraints on the service delivery has been the persistent problem of attracting and retaining experienced data processing professionals. After several years of decreasing success in recruitment efforts, despite increased commitment of time and dollars, management of the Systems Group decided that it needed "some kind of manpower plan" that would assist them in better forecasting manpower supplies in periods greater than one year, and thus enable them to plan more effectively to meet future needs. Because management did not have a complete understanding of the field of manpower planning, the first goal of the study was to develop a fuller comprehension of the discipline. Once that was achieved, the study would be narrowed to a more detailed analysis of the aspects that would lead to a means of forecasting manpower.

ACKNOWLEDGEMENTS

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Many employees at Alberta Government Services gave freely of time and information which helped no end. Special thanks go to Mr. B. Northfield for making this project possible in the first place.

Final recognition is well-deserved by family and friends who willingly listened while enduring continuing neglect. All of these people contributed in their own special way.

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1. ALBERTA GOVERNMENT SERVICES

Alberta Government Services, a provincial government department, was formed in 1975 to centralize the management and delivery of certain common service functions within the government, as a result of a government-wide reorganization.[1] The new department contained five divisions: the Operating and Maintenance Division, the Supply Division, the Administrative Services Division, the Public Affairs Division, and the Computing and Systems Division (to be later renamed the Information Services Division). The Computing and Systems Division was responsible for electronic data processing functions previously held by the Provincial Auditor, which could be roughly classified into two main areas: operations and systems. The Data Center Group was responsible for the operations side, which embraced what is commonly called "hardware" (the actual physical equipment) and all jobs related to feeding and maintaining the equipment. The Systems Group consisted of programmers and analysts who wrote programs and design business systems (software) to be run on the hardware.

One year after the formation of AGS, the Systems Group was organized into four branches: New Projects was responsible for developing new systems, Production Systems was responsible for maintaing previously established systems, Cross-Government Systems (later to be called

---

[1] Alberta Government Services, "Annual Report, 1975-76" (1976).

Financial Administration Systems) developed and maintained financial systems exclusively for the Controller's Office, and Planning and Support provided internal planning and training services. (See Figures 1 and 2 for structure.) In August of 1978, the planning function was separated from the Systems Group to be incorporated into a separate Planning and Policy Branch.

Branches were structured into a series of project teams, each headed by a Project Manager. The teams normally consisted of varying numbers of programmers and analysts. Occasionally, a team also contained a project clerk who performed various clerical support activities. The numbers and kinds of employees on teams partly depended on what kinds of employees were available as well as the work performed by the team at the time. (See Figure 3 for a sample project team structure.)

Traditionally, Government Services had complete control of electronic data processing activities for the provincial government, although user departments often had a few programmers or analysts working within the individual department to perform minor tasks. All new positions, hardware, or systems had to be approved by the deputy heads of Alberta Treasury and Alberta Government Services. Government Services was also responsible for procurement of private sector data processing systems services. Demand for electronic data processing (EDP) services within the government grew steadily in the years following the

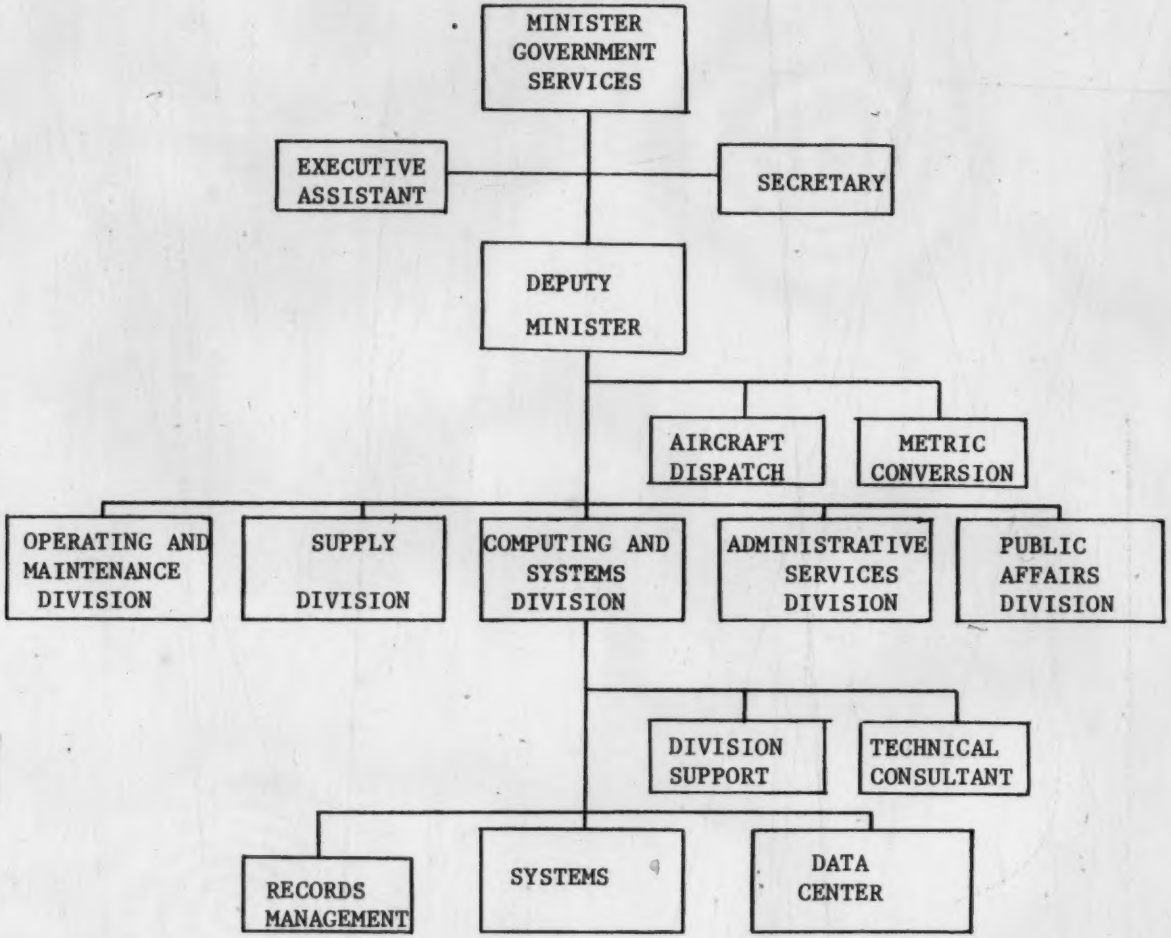

FIGURE 1. ALBERTA GOVERNMENT SERVICES ORGANIZATION, 1975-1976
SOURCE: ALBERTA GOVERNMENT SERVICES ANNUAL REPORT 1975-1976

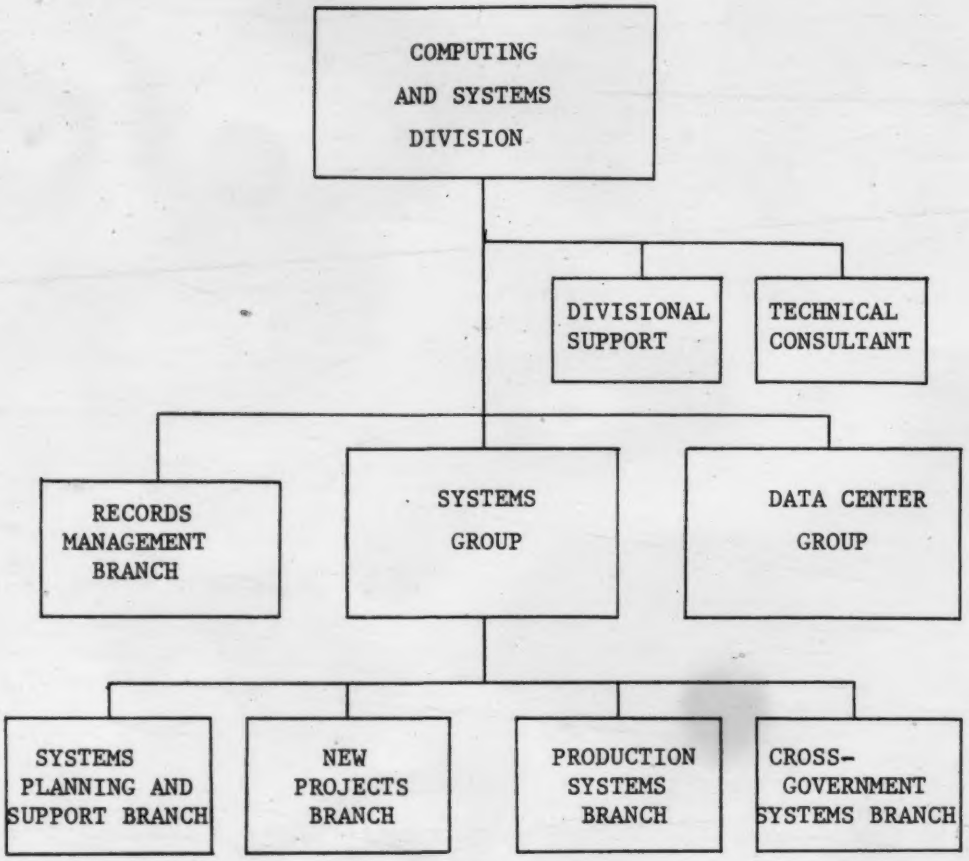

FIGURE 2. COMPUTING AND SYSTEMS DIVISION ORGANIZATION CHART, 1976
SOURCE: ALBERTA GOVERNMENT SERVICES ANNUAL REPORT 1976-1977

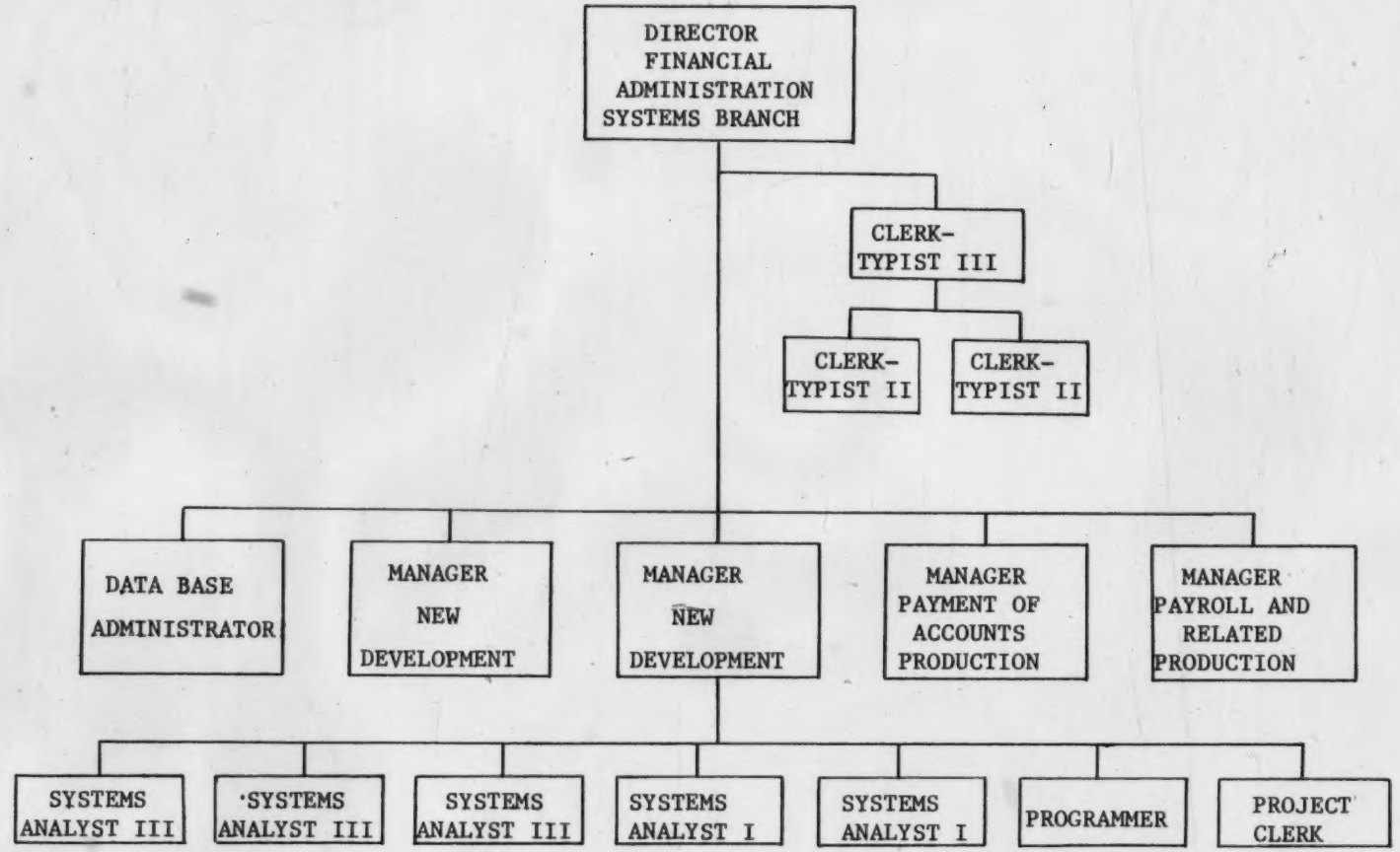

FIGURE 3. SAMPLE PROJECT TEAM STRUCTURE
SOURCE: FINANCIAL ADMINISTRATION SYSTEMS BRANCH ORGANIZATION CHART, AUGUST 1981

inception of Alberta Government Services. Since government policy supported the letting of work out to the private sector when practical, increasing amounts of systems development work was let to private consultants. In 1978, a Procurement Branch was formed within the Systems Group to tender, award, and administer contracts.

The general high demand for EDP led to a shortage of trained personnel throughout the industry, and both the private and public sectors have suffered from the imbalance. The provincial government has contracted out ever greater amounts of systems development work, [2] but the increased load on the private sector has tended to cause similarly understaffed consulting agencies to hire experienced analysts away from the government when possible. As a result, the Systems Group has suffered a continuing lack of experienced systems analysts. Although the Group also employs personnel in clerical and managerial positions, there has been less difficulty in recruiting to and retaining people in these categories.

Although most government positions are filled by local labour markets, Government Services has had to embark on more aggressive and dispersed recruitment campaigns throughout Canada and in Great Britain in order to meet the needs for systems analysts. Alberta Government Services recruits

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[2] In fiscal year 1977-78, AGS contracted out approximately one million dollars of systems work to the private sector; in 1979-80, $3,200,000 was contracted out. (Source: Annual Reports.)

at universities and technical schools, but the graduates do not meet the government's immediate requirements for experienced analysts. The overseas and out-of-province recruitment efforts have borne increasing overhead because of controlling agency requests for more detailed information to justify the expensive recruitment campaigns. The Personnel Administration Office (PAO) is a provincial department controlling formal personnel functions for Alberta Government departments, and although PAO has delegated much day-to-day classification and recruitment authority to departments, it still is highly involved in uncommon campaigns such as those initiated by Government Services. Overseas recruitment is carefully monitored by the federal Department of Manpower and Immigration, and certain conditions must be met before overseas recruitment activities are allowed. Recently, Manpower and Immigration has requested detailed manpower statistics on previously-hired immigrants, and AGS has had difficulty in supplying the information since measurements of that nature have not been taken, and the data is difficult to retrieve.

Another pressure on the Systems Group has been caused by the blossoming of the computer capacity held by the department. High demands for systems forced hardware growth to the extent that plans for two more data processing installations were initiated. Major installations already exist in Edmonton and Calgary, the third center will meet additional general data processing needs in Edmonton, and

the fourth center (a smaller, special purpose center) will be dedicated to Tax Administration. [3] Already the capability to process more and more systems has led to a concurrent growth of the need for production analysts. (See Figures 4 and 5.) In 1981, the original Production Branch divided into two Production Branches (A and B), each serving a number of the existing clients. In response to recent changes, the Systems Support Branch has also grown considerably, both through the expansion of present functions and through the addition of new ones, such as the responsibility for some common software systems. Part of the responsibilities of the Procurement Branch were reabsorbed into the Systems Support Branch, which has been renamed to the Application Support Branch. Other responsiblities were transferred to the Supply Division within the department. [4] (See Figures 6 and 7.)

As described, the Systems Group has been under increasing pressures since its formation, stemming from increased demand for services, a shortage of experienced personnel across the marketplace, and the rapid changes associated with the entire EDP industry.

The magnitude of the overall changes has heightened management's concerns about its ability to recruit adequate numbers of trained personnel to meet future demands, especially when considering the shortage of qualified

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[3] Alberta Government Services, Information Services Division, "Strategic Processing Plan, June,1981" (1981).
[4] Alberta Government Services, Information Services Division, Computer Systems Group, "Operational Plan 1981/82" (1981).

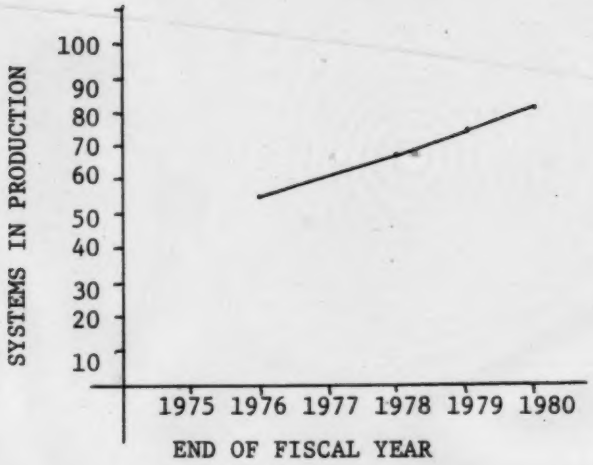

FIGURE 4. SYSTEMS IN PRODUCTION, BY FISCAL YEAR-END
SOURCE: ALBERTA GOVERNMENT SERVICES ANNUAL REPORTS

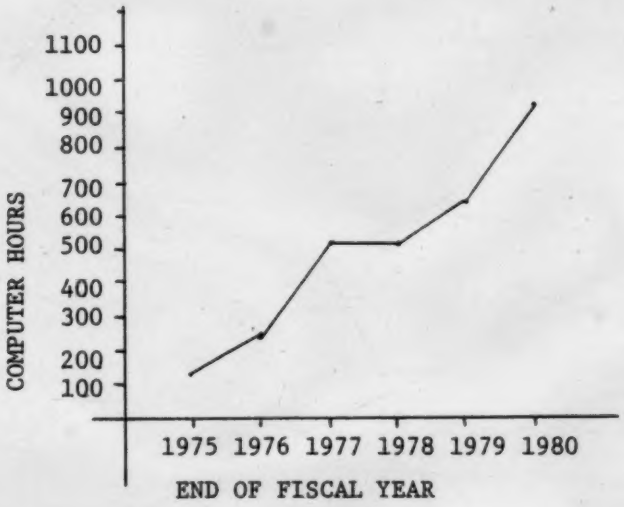

FIGURE 5. COMPUTER HOURS USED DURING FISCAL YEAR
SOURCE: ALBERTA GOVERNMENT SERVICES ANNUAL REPORTS

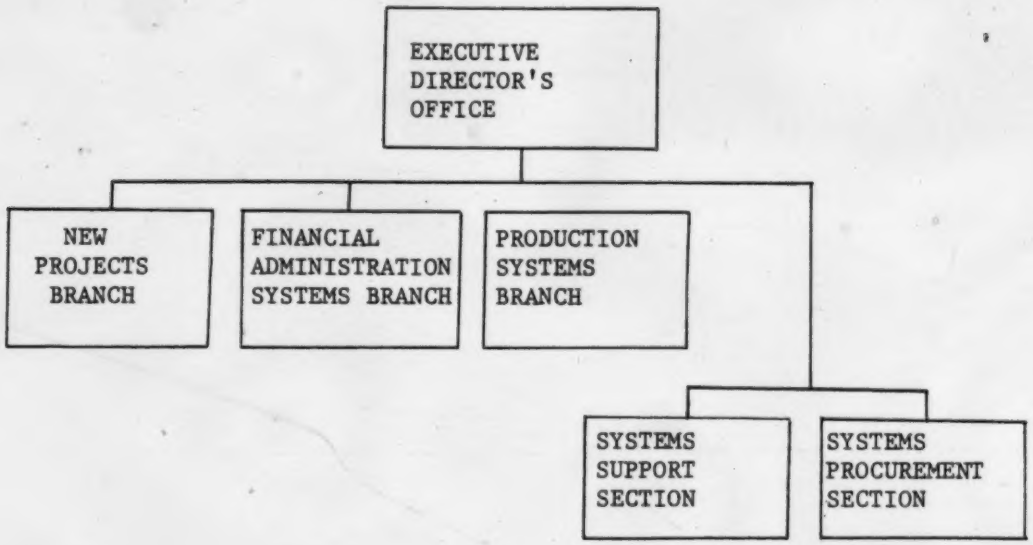

FIGURE 6. SYSTEMS GROUP EXISTING STRUCTURE, 1980-1981
SOURCE: ALBERTA GOVERNMENT SERVICES COMPUTER SYSTEMS GROUP OPERATIONAL PLAN, 1981-1982

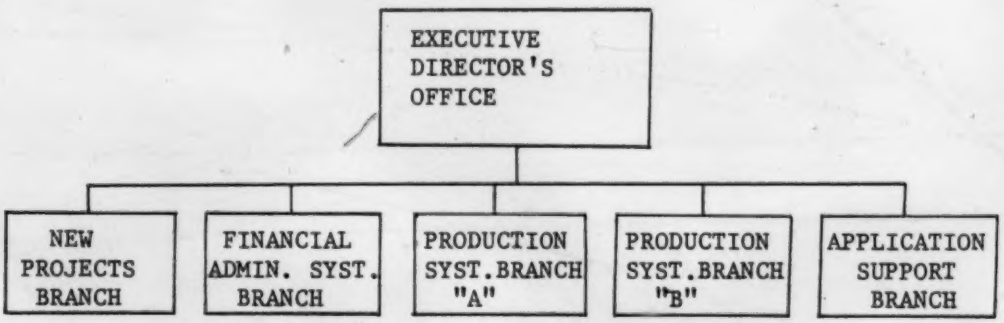

FIGURE 7. SYSTEMS GROUP PROPOSED STRUCTURE, 1981-1982
SOURCE: ALBERTA GOVERNMENT SERVICES COMPUTER SYSTEMS GROUP OPERATIONAL PLAN, 1981-1982

personnel. Thirty-five new positions were created for the 1981-82 budget year, bringing the proposed establishment up to 181 positions, and adding significantly to the recruitment burden. [5] In addition, management is now concerned about how they might predict the kinds of analysts that will be needed in future years. Ultimately, the Executive Director of the Systems Group wishes to be able to produce a three year rolling projection of available and required manpower. Side issues under review are those of employee retention, attrition, and career planning to meet the needs of weak areas of the organization.

1.1 Current Manpower Management

Although the Systems Group did not practice manpower planning in the most formal sense, many systems used to administer personnel were already present, and could contribute to general manpower planning. [6] The majority of these systems are not under the direct control of the Systems Group.

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[5] Ibid.

[6] The following information is based on the researcher's personal knowledge of the organization, gained through two and one-half years experience as a Personnel Administrator in the Alberta Government Services Personnel Branch.

1.1.1 Classification Systems

The Alberta Government uses a common, centralized classification system to determine job types and levels. The central concept to the classification system is that of a "position". A "position" represents a set of duties that may be accomplished by one person. Positions are administered separately from the individuals that hold them. Depending on the duties to be performed, a position may be classified as belonging to a category of job types (such as Systems Analysts) and it may be classified at a specific level (such as a Systems Analyst III).

For administrative purposes, each specific position is identified by an eight-digit position number. Classification levels may also be identified by a numeric code (class number). For pay purposes, a classification level is matched to a specific salary grade (or range of grades) on a salary grid. Salary grades may have more than one rate of pay (called periods) so that an employee's salary may be incremented to recognize satisfactory performance without having to promote the employee to a higher job classification. [7] A person filling a specific position must meet specified minimum education and experience standards in order to fill that position. However, if their qualifications are

---

[7] To illustrate, a person may occupy position 2609-9999. The position (and therefore the person holding it) is classified as a Systems Analyst III (class number is 0796) and the employee is currently paid at salary grade 72, pay period 4. The employee's class title is Systems Analyst III, but their job title is 'Production Analyst".

higher than necessary, the position is not normally changed to a higher level. Instead, the individual must apply for another position of a higher level. A position level changes only when the required duties change, except in the case of a "growth series" of positions, which will be explained later in the chapter. One of the Personnel Administration Office's functions is to provide classification standards to departments, which must have a written job description on file in PAO for every position held on the department's establishment. The Systems Group has the authority to establish the number of employees they need through the government budget system, but AGS Personnel or PAO must approve the position classification level at which the employees are to be hired, using the classification standards as the benchmarks for determining position type and level. Systems comprises a variety of job types including management positions, systems analysts, programmers, clerks, and online data processing operators. This study addresses only the programmer and analysts positions, which form the bulk of the establishment. Although the clerical and management positions in general will be viewed briefly in the context as part of potential career paths within the Systems Group, positions in these categories have not experienced the same employee turnover as have those in the programmer-analyst categores.

Programmer positions are positions within the government bargaining unit represented by the Alberta Union

of Provincial Employees. Wages and fringe benefits are bargained collectively. Systems Analyst positions are divided into levels I through IV, reflecting increasing levels of technical knowledge and expertise. (See Figure 8.) These positions are excluded from the bargaining unit because of the confidential nature of some of the systems developed and maintained (notably salary systems), and so wages and benefits are set arbitrarily by the Personnel Administration Office after review of similar positions in private and other public organizations. Benefits are essentially similar for bargaining unit and excluded positions, although there are some minor differences such as in overtime provisions.

The Systems Analyst positions are also differentiated by the kind of work done, and consequently there are development analysts, production analysts, analysts that consult on systems procurement and contract administration, analysts that conduct and contract out training in data processing, and analysts that formulate and evaluate systems standards. The categories are not mutually exclusive, and until an employee reaches the level of Systems Analyst IV they are not normally considered to be specialists.

When any type of position is created in the Alberta Government, a description of its duties and responsibilities is forwarded to either to the departmental personnel office, or PAO, depending upon which agency holds classification authority. The department holds delegated authority for the

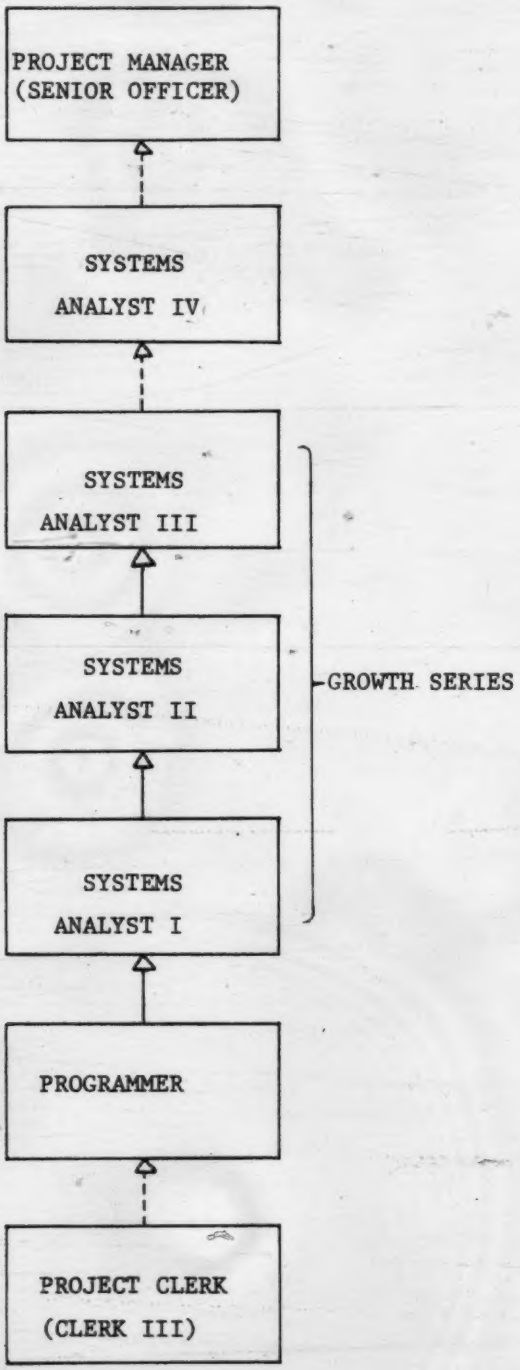

FIGURE 8. PROGRAMMER-ANALYST CLASSIFICATION STRUCTURES

classification of Programmer and Systems Analysts I to III positions. The Personnel Administration Office classifies Clerk III, Systems Analyst IV, and management positions, using departmental recommendations in its decisions. For most positions, the classification is predicated on the nature of the work to be done. However, the progression from Programmer to Systems Analyst I and on up to Systems Analyst III is considered to be a growth series, and a position can be upgraded on the basis of the incumbent's increasing skill level, subject to some time considerations (an employee must spend a minimum of one year at each level) and performance considerations. The upgrading of an employee from one level in the growth series to the next may occur upon a project manager's recommendation, with a departmental personnel officer's concurrence. The minimum time stipulation of one year at each level does not imply an automatic promotion each year--rather, the individual must meet the manager's expectations of performance. To be promoted to a Systems Analyst IV or managerial position, an individual must apply on a job competition to be interviewed and compared against other applicants. Entries from other types of jobs into the programmer analyst series are also achieved through the competition mechanism, but once an employee enters the series, their promotions are determined by the previously described recommendation process. A mechanism exists to exempt personnel from the necessity of applying on a competition in special cases, but its use is discouraged and

therefore is subject to rigid constraints. (An exemption from competition requires both Deputy Minister and PAO approvals. The approvals are granted only after it has been conclusively shown that no other potentially suitable candidates exist.)

1.1.2 Recruitment Systems

The Personnel Administration Office is responsible for all recruitment and selection activities in the Alberta Government, but it delegates a considerable amount of responsibility for this to the departments. However, PAO retains control over the advertisement of any vacant positions, so that all recruitment activites must be initiated through PAO in order to obtain advertising. The files of applicants are sent to the department and the actual interviews are conducted within the individual departments. Once a successful job offer has been made, the recruitment file is returned to PAO for a post-audit check.

No vacant positions may be filled permanently without the initiation of a job competition, except in the case of transfers between positions with identical levels, or in the rare cases of exemptions.

Entry to the Programmer-Analyst series can occur through several different recruitment programs. (See Figure 9.) Generally, recruitment activity is not initiated unless there are vacant positions, and thus potential applicants are not considered for interviews unless there is a

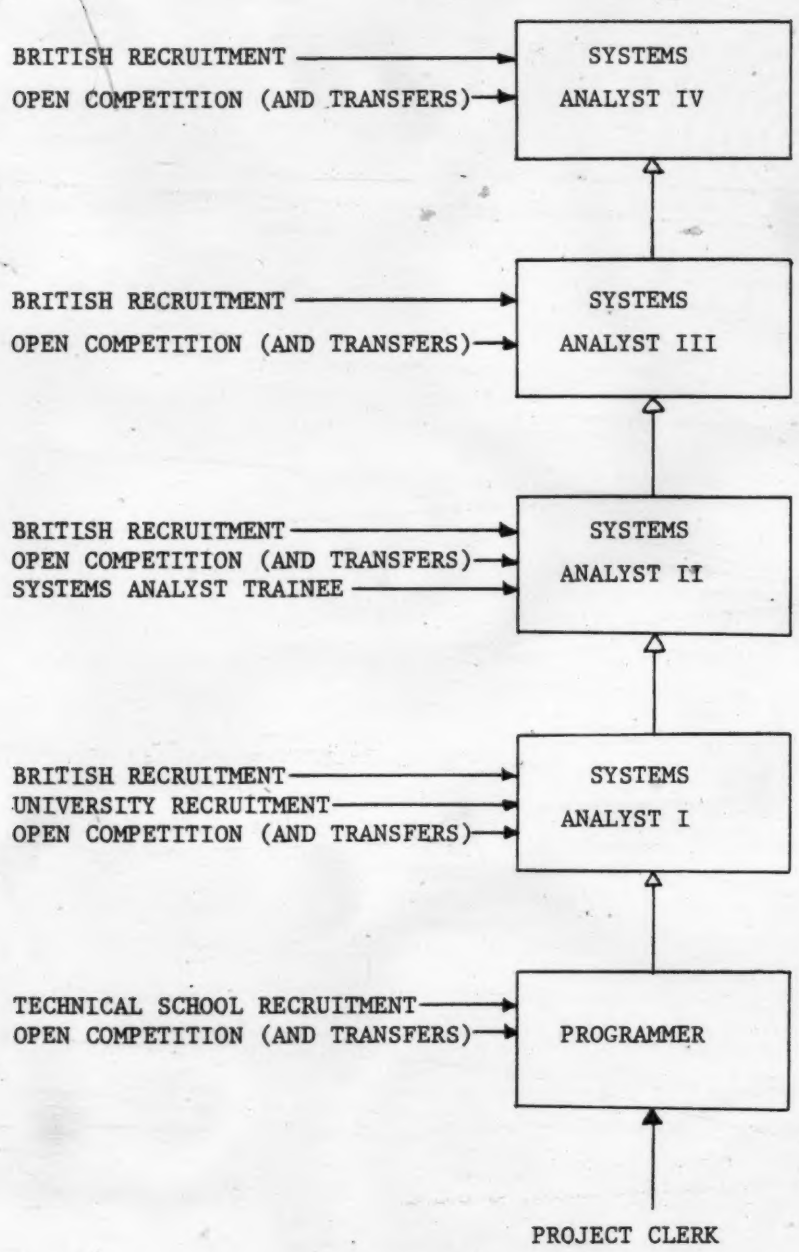

FIGURE 9. PROGRAMS OF RECRUITMENT INTO THE PROGRAMMER-ANALYST SERIES

competition in progress. Although their resumes may be held until a competition occurs, the high demand for EDP personnel almost guarrantees they will have found other employment by the time the government initiates a competition. This somewhat artificial barrier to recruitment action may be dropped if the government changes from managing the manpower pool on a position basis to a manyear basis. (A manager may budget for 20 positions, but because of vacancies may only get 12 manyears of actual people time. With a manyear allotment, a manager can overhire during one period, but through expected attrition still meet the budget at the end of the budget cycle.) Although there is no definite indication that the government will change to a manyear system, the matter is under consideration.

Entry to a programmer position may occur in three different ways. The most common is through formal Systems Group recruitment drives at technical schools across Canada. Potential graduates are interviewed by Systems managers, and are offered positions contingent upon successful completion of a certified program. Relocation assistance is provided to students moving to Emonton to work for the group. The Technical School Recruitment Program is conducted annually.

A second means of recruiting to programmer positions is intended for clerical personnel who wish to upgrade themselves into a technical/professional level of work. Junior clerks may apply on a competitive basis to become Project Clerks (Clerk III's) who provide clerical support for a team

of programmers and analysts, under the direction of a Project Manager. The Project Clerk is expected to take in-house courses and night courses from NAIT or the university to develop programming skills, and when the clerk reaches a sufficient level of expertise they are encouraged to apply for a programmer position through the competitive route.

A third means of entering a programmer position, the open competition route, is more general. In an open competition, the government will accept any applicants. Their training and skills are subsequently assessed against set standards as well as against the skills of other applicants. Although technical school graduates are preferred, applicants with no training but related experience will have their experience assessed on an equivalency basis to education. The assessment is monitored carefully by Personnel, but it is open to managerial discretion regarding the applicability of the experience.

Entry to a Systems Analyst I position can occur through a University Recruitment Program, promotion from a Programmer position, or through open competition. A University Recruitment Program is conducted concurrently with the Technical School Recruitment Program, and it is similar in almost all respects. Offers are made to students graduating from three- or four-year programs with specialization in courses relating to data processing. No special recruitment efforts are made to attract graduate

students although their applications are considered to be desirable. Relocation assistance is provided to out-of-town students.

Systems Analyst II and III positions are normally filled through internal promotions or through open competitions advertised within Alberta and throughout Canada. For the last two years, however, the Systems Group has also conducted special recruitment activities in Great Britain to hire experienced analysts. Relocation assistance is provided to successful candidates. The out-of-province and British recruitment programs are expensive, time consuming, and subject to outside agency approval, but they are the major sources of experienced personnel.

Government Services can accept transfers to any job level from other government departments but traditionally these personnel are asked to apply on an open competition so that their qualifications may be assessed relative to those of others by an interview panel. There is some disparity between various departments' assessments of skill and experience levels, and the interview process is intended to rate incoming personnel relative to Systems Group employees.

The most recent program undertaken by the Systems Group is known as the Systems Analyst Trainee Program. The Systems Group has requested applications from current government employees holding non-dataprocessing degrees. Eight candidates have been accepted to enter a program featuring both in-house training and work experience, intended to

develop the trainees into Systems Analyst II's. The first competition for this program was only opened in October, 1981, with the successful applicants to start in February, 1982, and so there has been little opportunity to assess the program's full impact yet.

1.1.3 Training Systems

The Personnel Administration Office provides virtually all training for small departments, but larger departments such as Government Services offer some in-house training through the Personnel Branch of the department. The Systems Group is unusual in that it provides extensive data processing training to its own personnel and to those in othe departments. Personnel Branch training and Systems Group training are administered separately.

Alberta Government Services has its own pool of organizational development specialists who have been responsible for projects such as the development of a departmental performance appraisal system that supplements the one given by the Personnel Administration Office. Department personnel meet annually to set goals that are communicated down through the organization. Supervisors are then expected to meet with their employees individually to develop personal work objectives for the year, with departmental objectives as the basis. At the end of the appraisal period, the performance of each employee is measured against the goals they developed with their

supervisor.

A skill inventory was developed for managers in 1978 as a result of a manpower planning program initiated by PAO, but the inventory was never updated and consequently it was not put to use. Although the study led to recommendations that manpower planning be considered for all computer personnel within the government, apparently no followup action was taken. [8]

1.1.4 Planning Systems

The most formal planning of the various manpower systems just described essentially comes from the budget process. Budget planning normally occurs in the context of what programs will be kept, added, or deleted. Programs justify numbers of employee postions. The budget planning process does not usually consider how programs are actually designed, implemented, or administered: these issues are left to management. The budget planning process merely provides a general framework for manpower plans since it only provides numbers of positions with which management can work.

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[8] Alberta Government Services, "Manpower Planning in Alberta Government Services, March 10, 1978" (1978).

1.1.5 Information Systems

Information about this wide variety of personnel related systems originates out of several areas. For example, the government-wide payroll system, which is part of the Alberta Financial Information System(AFIS), belongs to the Controller's Office. Systems Group managers receive budget-related reports such as reports of salary cheques paid to employees. Some forms produced by AFIS are held on personnel files, supplying information about salary and position. The departments have little access to secondary information that could potentially be made available through AFIS. The system is considered to be a data base system, and the computer files do carry the information that would be useful for manpower planning activities such as forecasting. However, since the system is dedicated to the Controller's Office, it would be difficult to obtain information for departmental use.

The Personnel Administration Office once supplied a chart-type report of organizational structures to personnel branches in departments, but the system fell into disuse for approximately eighteen months. The Personnel Administration Office recently developed a system to report training activities throughout the Alberta Government, with the intention of being able to develop individual training profiles, but only limited information is available to departments. PAO is also in the process of developing a new personnel information system, but the system appears to be

intended solely for the use of PAO.

The Systems Group runs a time reporting system which monitors hours of work for each employee so that analyst time may be charged to user departments. The system supplies information on the use of flextime, sick leave benefits, training time, and vacation usage, as well as actual hours of time spent on each work project. One byproduct report from this system is a listing of training an employee has received or will receive during a one-year period. In addition, the Systems Group monitors position vacancies and recruitment action through the use of a small reporting system.

A variety of manual information systems within Alberta Government Services provides the remaining information available about Systems Group employees. None of the manual or automated systems are closely coordinated to one another, and information on personnel is more often a byproduct of a system intended for another purpose, such as the provision of financial information. Because different groups are responsible for different systems, information sharing tends to be limited.

The Personnel Branch of Alberta Government Services keeps a variety of records on each employee, including personnel records, job descriptions, and classification records. This information is not integrated into any one particular format that might be condusive to overall assessment of the personnel working for the Systems Group.

2. LITERATURE REVIEW

The literature research for this study was conducted with the intent of meeting two specific goals. The first goal was to gain a general understanding of manpower planning as a discipline, and the second goal was to focus on the components of manpower planning that might lead to the development of forecasting models. There is fairly extensive literature on manpower planning. Initial studies in the field stemmed from attempts to cope with high industrial turnover before and during World War I. A significant number of studies were published around 1960, and to the present continuing efforts have established a variety of approaches to manpower planning. Conferences sponsored by NATO took place in both 1967 and 1977 to address the topic. The 1967 conference focused on manpower planning in a defence context and the second conference considered manpower planning and organization design.

Definitions of manpower planning vary, but a few representative examples will serve to illustrate some common themes. Stainer utilizes a British Civil Service definition which describes manpower planning as the "strategy for the acquisition, utilization, improvement, and preservation of an enterprise's human resources". [9] He goes on to elaborate "Manpower planning aims to maintain and improve the ability of the organization to achieve corporate objectives, through

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[9] Gareth Stainer, Manpower Planning: The Management of Human Resources, (London, England: William Heinemann Ltd., 1971), p. 3.

the development of strategies designed to enhance the contribution of manpower at all times in the foreseeable future". [10] Killian defines manpower planning as the "process by which an organization ensures that it has the right number of people, with the right kinds of qualifications, at the right place, and at the times when they can be most economically utilized". [11] Bartholomew and Forbes define manpower planning in a general sense as "the attempt to match the supply of people with the jobs available to them". [12] They go on to comment that "Manpower planning, unlike individual career planning, is concerned with numbers, that is, with having the right numbers in the right places at the right time". [13]

Manpower planning can occur at the corporate, industrial, or national levels, and each level involves somewhat different analysis and modified techniques because of the manpower pool studied and the somewhat differing objectives of the researchers. Research on the components of corporate manpower planning revealed such diverse areas as training and development, task analysis, skill classification and inventories, career planning, performance appraisal, and organizational design. From this perspective it appeared that the Systems Group already had some manpower

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[10] Ibid., p. 3.
[11] Ray A. Killian, Human Resource Management: An ROI Approach, (New York: AMACON, 1976), p. 42.
[12] David J. Bartholomew and Andrew F. Forbes, Statistical Techniques for Manpower Planning, (Chichester, England: John Wiley and Sons Ltd., 1979), p. 1.
[13] Ibid., p. 1.

planning systems in effect. For example, the Systems Group used formal job classification systems, recruitment systems, and performance appraisal systems. None of these topic areas led directly to forecasting, however, and so only a general survey was taken of each.

To focus on the issue of forecasting, a good perspective is provided by David Bell, who delineated five elements of manpower planning:

1. Systematic analysis of manpower resources
2. Forecast of manpower demand (or requirements)
3. Forecast of manpower supply
4. Reconciliation within the constraints of the company's circumstances
5. Plans for action [14]

Systematic analysis of manpower resources includes analysis of internal and external supplies of manpower, relative to the organization. Demand forecasting stems from analysis of corporate objectives and strategic plans, with the purpose of quantifying desired corporate output to then derive numbers and kinds of employees that will be needed to meet those demands. Supply forecasting may be used to predict manpower supplies from either the internal or the external labour markets. Comparisons of demand and supply forecasts, and review of corporate goals and constraints provide the framework for ultimately developing the manpower plan.

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[14] David J. Bell, Planning Corporate Manpower, (London: Longman Group Ltd., 1974), pp. 9-10.

There is fairly extensive literature on manpower forecasting at all levels, and much research has been conducted in civil service settings, particularly in Great Britain. [15] Most forecasting models are intended for large organizations with significant numbers of employees (eg. 500 to 1000) , and only limited work has been done on small organizational units. Virtually all models are based on data gathered to measure the stocks of personnel within the organization at any one point in time, and the flows of people from one time period to the next. Flows occur as a result of processes such as hiring, resignation, retirement, transfers, promotions, and demotions. The choice of one model over another is partly dependent upon the data available, and on the assumptions the organization wishes to make in analyzing the data.

Canadian use of manpower forecasting is visible only at the national levels. The Department of Manpower and Immigration uses both a short-range and a long-range forecasting model (named FOIL and COFOR respectively) to predict anticipated surpluses and shortages of specific occupational types across Canada. Although it is expected that some companies in Canada forecast manpower needs and supplies, their efforts are rarely published.

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[15] A. R. Smith, ed., Manpower Planning in the Civil Service, (London: Her Majesty's Stationery Office, 1976).

3. OUTLINE OF THE STUDY

Because the Systems Group has so little integrated data upon which to base a manpower forecast, the purpose of this study shall be to provide a detailed systematic analysis of the Systems Group's internal supplies of programmers and analysts, and an analysis of the behaviour of the internal manpower pool since the final major reorganization in April, 1976. The focus on the internal as opposed to the external supplies was considered to be most practical since some data was already available, and it would meet the Systems Group's requirements for information to justify recruitment activities to outside agencies. Detailed data is also a precondition for the establishment of a forecasting model.

The subjects for the study are all the programmers and systems analysts that have been employed by the Systems Group of Alberta Government Services on or since April 1, 1976, until September 30, 1981. April 1, 1976, was chosen as the starting date because the organizational structure of the Systems Group was established into the form still present in 1981. Although some changes in structure have occurred after that date, they involved only 3 analysts, and the changes were not judged to be large enough to significantly affect the data. The September 30, 1981, cutoff date was arbitrarily chosen.

Information was gathered almost exclusively through analysis of departmental records. All files were reviewed directly by the researcher except in the case of personnel

files held by departments other than Alberta Government Services. Since departments were reluctant to release confidential files, in these instances a personnel representative from Government Services obtained as much information as possible over the telephone. If data was unclear from the records, attempts were made to discuss the item with the Systems Group manager responsible for the employee under questions, to clarify any discrepancies.

For each employee, the following pieces of information were gathered to form a profile: [16]

NAME

SEX (Male, Female, Unknown)

DATE OF BIRTH

MARITAL STATUS (Married, Single, Unknown)

COMMENCEMENT (Branch, Class Number, Title, Position Number, Grade and Period, Effective Date, Provision of Monetary Assistance for Relocation)

EDUCATION AT TIME OF COMMENCEMENT (Related University Degree, Related Technical School Diploma, Various Courses, Unknown)

RECRUITMENT SOURCE (Open, School Recruitment, British Recruitment, Transfers from Other Departments, Transfers Within Alberta Government Services, Unknown)

PROMOTIONS (Branch, Class Number, Title, Position Number, Grade and Period, Effective Date)

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[16] Recruitment and termination categories will be explained in Chapter Four.

ANNUAL INCREMENTS (Branch, Class Number, Title, Position Number, Grade and Period, Effective Date)

TRANSFERS (Branch, Class Number, Title, Position Number, Grade and Period, Effective Date)

TERMINATION (Branch, Class Number, Title, Position Number, Grade and Period, Effective Date)

REASON FOR TERMINATION (Employment Reasons--Promotion to Management Position in AGS, Transfer to non-Systems Group Position in AGS, Transfer to Another Department, Employment outside Alberta Government; Family Reasons; Personal Reasons; Unknown)

Information was available from the following kinds of records: individual personnel files in AGS, personnel files in other departments, position cards (AFIS102 and PA033), pay unit rotary card files, attendance cards, quarterly reports, monthly staff reports, and managers' files.

Education categories were derived from recruitment and classification standards promulgated by the Personnel Administration Office. A related university degree is one that include specialization in courses relating to programmer analyst duties. A Bachelor of Science Degree in computing science, math, or operations research is considered to be related, and occasionally a Bachelor of Commerce Degree is considered to be related when it includes work in several computing science courses. A related diploma is one in computing technology from an institute of technology or a college. The designation of various courses

includes night courses taken from colleges and universities, or courses taken during employment. Because of the technical nature of data processing, some kind of training is generally required to enter the field, and training is necessary to keep abreast of changes. Thus, the minimum education any employee will have falls in this category.

Note was made of organizational events such as reorganizations, classification reviews, and pay reviews.

Personnel files held in the Personnel Branch of Alberta Government Services [17] were used as the primary source of information since they potentially contained information on each of the items listed above. Many pieces of information were present on the personnel file more than once, thus allowing for a double-check on the accuracy of the information. Information on the personnel file was more likely to be valid than that from other sources since many of the forms holding the information were used for pay purposes, and thus were subject to more rigorous checks and audits. If there was a discrepancy between information from a personnel file and that from another source, regarding dates, pay levels, and positions numbers, the personnel file was considered to be the accurate source. A list of the variety of documents that may be found on a personnel file is available in Appendix A.

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[17] Personnel files were held at AGS head office for employees on strangth dating back to 1978. The files of employees terminating before 1978 are stored in a warehouse managed by the Records Management Branch of AGS.

Position cards hold basic personal data on each employee, and were used to relate individual personnel to specific positions on the establishment. Position cards are held separately from the personnel files until the employee terminates, at which time the cards are added to the file. The cards provided the most concentrated information on positions held by the employee and the respective effective dates.

Pay Unit rotary card files were used by pay clerks to provide a convenient listing of each employee handled by the pay unit. The cards held minimal information but they were useful in providing commencement and termination dates for employees that were transferred to other departments, as well as the name of the receiving department.

Attendance cards were occasionally useful to confirm the employment of a person that was on extended sick leave. There was only one instance of this in the Systems Group study.

Quarterly reports are produced by each of the branches in the Systems Group, and provide, amongst other things, a summary of staff movements during the three month period being reported. Often the quarterly report would provide more exact details on an employee's termination than would the personnel file. For example, the quarterly reports often listed a terminating employee's new employer, while the personnel file only contained a general letter of resignation that merely described the expected last day of

employment with the government. In these cases, the information provided by the report was used in the employee profile.

Monthly staff reports have been produced through the years covered by the study, listing the Systems Group employees by level and branch. The personnel files often omitted specific mention of the branch in which the employee worked, and so information from the monthly reports was used in preference.

Manager's files sometimes contained memos to or from an employee regarding relocation provisions, transfers, or terminations, and this information was used to confirm or expand upon that derived from other sources.

4. ANALYSIS

The data gathered for the five and one-half year period of the study revealed 217 individual employees that had occupied at least one programmer or systems analyst position. In order to facilitate analysis, the total time was broken into eleven six-month periods so that data from forecasting models could be tested against individual periods. The choice of a time interval is important for modelling considerations since it must be long enough to allow personnel movements to occur, but short enough that there are as few multiple movements as possible. [18] Most promotions in the Systems Group would occur a minimum of a year from the last promotion, given current recruitment and classification standards, and transfers would be expected to last longer than six months, so a six-month interval should prevent the occurrence of multiple movements. The choice of a six-month interval was most useful for the purposes of testing the manpower models discussed in Chapter 5, but it did not prove to be the best time division for the analysis of the data collected. After the analysis had occurred, it was noted that seasonal effects were noticeable in recruitment activities, and to some extent promotions may have been effected. This problem could be overcome by merely regrouping the data into one year periods.

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[18] Sang M. Lee and Gary D. Thorp Jr., eds., Personnel Management: A Computer-Based System, (new York: Petrocelli Books, 1978), p. 77.

Alberta Government Personnel Regulations state that if an employee commences on or before the fifteenth day of a month, they are considered to have started on the first day of that month for the purposes of evaluating seniority and pay increments. [19] This convention was followed in the analysis. To measure the length of service of an employee, their time of employment with AGS was broken down into half-month intervals. The intervals were determined on the basis of the calendar month: the first to the fifteenth days of the month constituted one interval, the sixteen day to the end of the month constituted a second interval. An employee starting at any day during an interval was considered to have been on strength for the whole of the interval. Since this arbitrary mechanism could bias the results slightly in favor of longer periods of employment, another convention was followed: if an employee terminated on any day during a half-month interval, they were considered not to have worked any part of that interval. [20]

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[19] General Pay Schedule Regulations, Part 3, Bargaining Unit Official Pay Plan, "Personnel Manual of Bargaining Unit Employees", Alberta Personnel Administration (1981), p. 4.

[20] Some examples may clarify these distinctions.
An employee commencing March 14, 1979, was considered to have commenced on March 1, 1979, for length of service calculations. An employee commencing on March 31, 1979, was considered to have commenced on March 16, 1979.
An employee terminating on March 14, 1979, was considered to have finished work on February 28, 1979. The termination date was considered to be the day following the last day of the employee's presence at work: thus, if an employee's last day of work was March 15, they were treated as having terminated on March 16. As a result they would have had a one-half month interval of service during the month of March.

Complete data was not available for all employees. The length of service of four of the 217 employees could not be calculated due to lack of commencement and termination information. Tombstone information, such as birthdate and education, was not available for a total of 15 of the 217 employees because their personnel files could not be traced. In all cases, secondary information from other records was used whenever possible to allow for inclusion of the employees in the analysis.

Although marital status was included in the study as an attribute to be recorded, the researcher found it difficult to ascertain accurately from the information kept on file. An employee's marital status could change during their term of employment without it necessarily being recorded. Because of current employment standards, an employer could not treat employees differently only on the basis of different marital status; therefore, no realistic recommendations could be made concerning the affects of this attribute. In light of these considerations, marital status was not included as part of the analysis.

4.0.1 General Manpower Pool Characteristics

Two concepts are fundamental to manpower analysis: those of stocks and flows. The stock is all of the personnel present within a group at one point in time. Flows are movements of personnel from one state to another between two points in time. Recruitment, terminations, promotions,

demotions, and transfers are all examples of flows. [21] The Systems Group manpower pool will be analyzed using both concepts. Flows will be divided into three categories: recruitment, terminations, and internal movements (promotions, demotions, and transfers). To analyze stocks, data was always taken from the first day of the period under analysis, before any movements had occurred. If a flow occurred at the transition point between one period and the next, the flow was considered to have occurred in the earlier period.

Despite the growth of data processing overall, the size of the Systems Group pool of employees has only increased from 73 to 93 in number during the total period of the study, showing a 27% total growth. (See Figure 10.) When contrasted with the 45% growth of systems in production in 5 years, and a 620% growth in computer hour usage in 6 years (as per Figures 4 and 5), the difficulties the Systems Group has experienced in matching the data processing growth become more visible. The total numbers of employees on strength follows an erratic pattern, which is reflected to a lesser degree in the patterns of the numbers of employees in each branch. Production Systems and the Financial Administration Systems Branch show some growth in size, while Systems Support has remained relatively constant, and New Projects has diminished.

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[21] David J. Bartholomew and Andrew F. Forbes. Statistical Techniques for Manpower Planning, (Chichester, England: John Wiley and Sons, Ltd., 1979), p. 3.

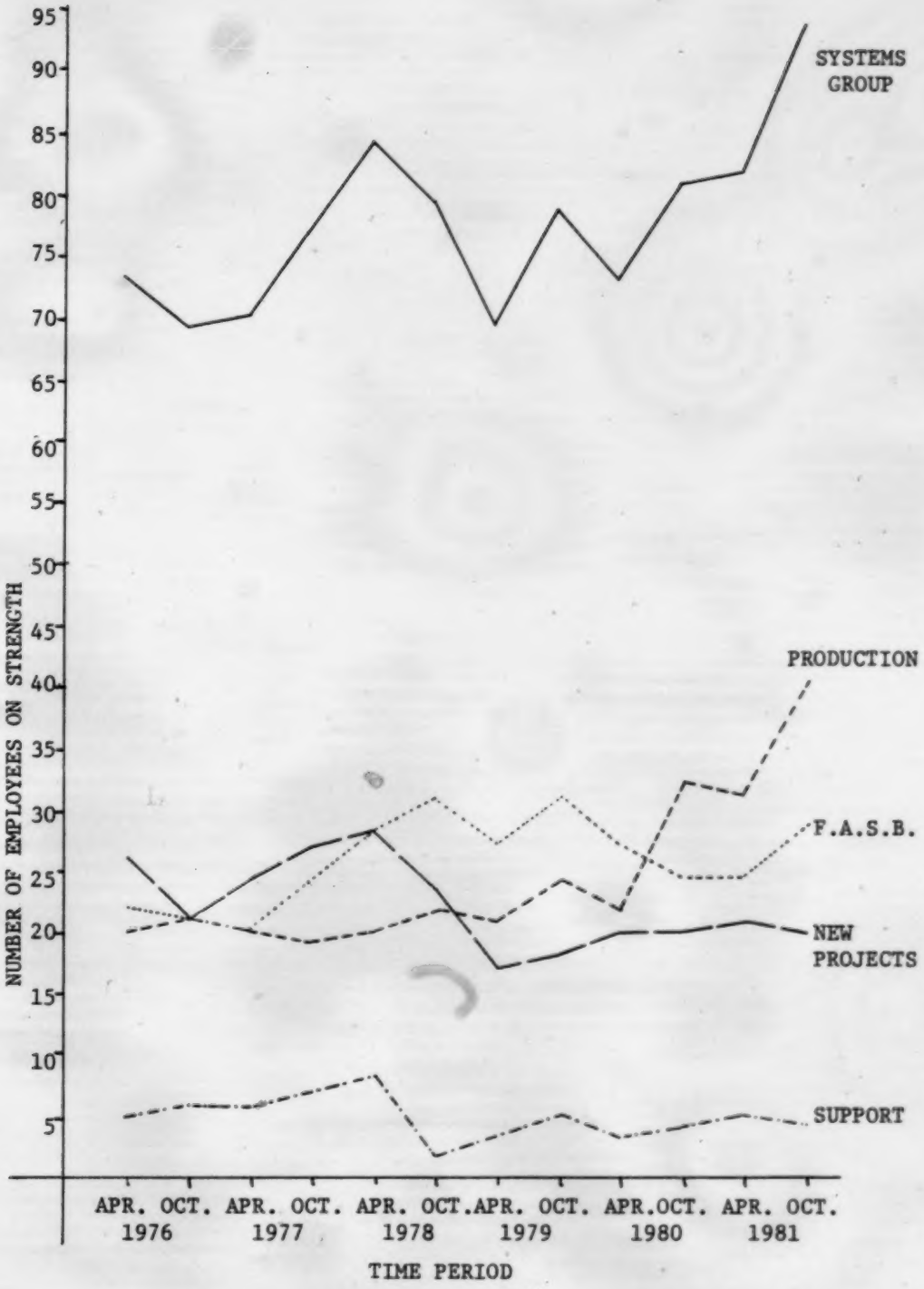

FIGURE 10. NUMBERS OF EMPLOYEES ON STRENGTH, BY BRANCH, AND PERIOD

A breakdown of employees by levels shows some marked trends in the composition of the manpower pool. In April 1976, Systems Analysts I's, II's, and III's comprised three quarters of the pool, in approximately equal numbers. By 1978, Systems Analysts III's formed almost half of the manpower complement, and were by far the most dominant group. After 1978, the numbers of Systems Analyst III's dropped steadily while the numbers of programmers and Systems Analysts I's and IV's rose. In 1981, in terms of levels of employees, the manpower pool was more homogeneous in composition than at any point previous. (See Figure 11.) Table 1 indicates the breakdown of manpower stocks into levels. Percentage figures show the proportions of each level have varied considerably through the period of the study. In 1978, Systems Analyst III's comprised almost one half of the total population. Systems Analyst II's formed the next largest proportion, and together the two groups constituted two thirds of the population. Management therefore had a solid base of experienced analysts. By April, 1981, the numbers of Systems Analyst II's and III's had dropped considerably in relation to the rest of the population. Numbers of Systems Analyst IV's have risen strongly since 1980, which may offset the loss of experienced analysts at the lower levels.

An analysis of both the age and length of service of manpower stocks shows that age is the more consistent attribute of the manpower pool. (See Tables 2 and 3.)

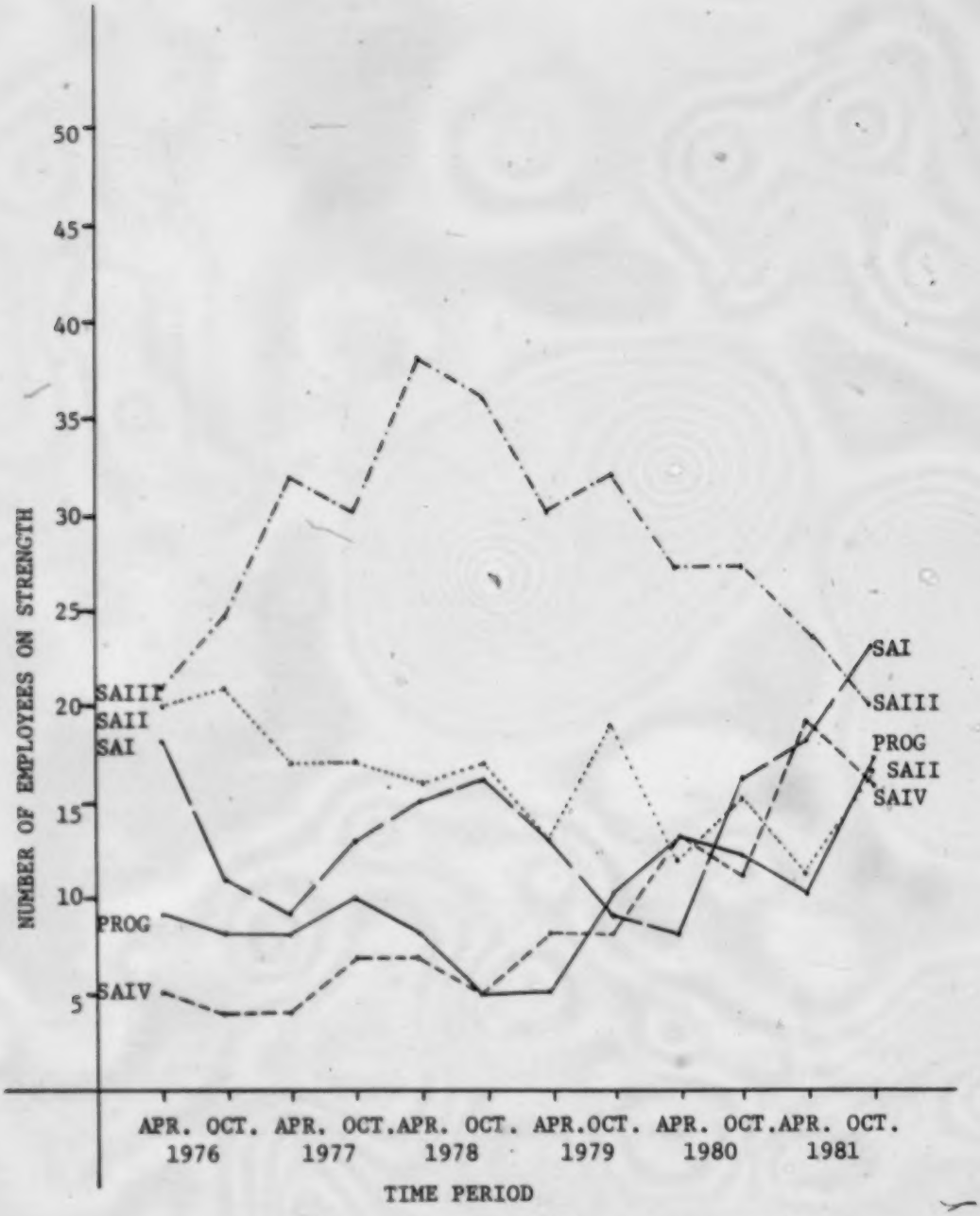

FIGURE 11. NUMBER OF EMPLOYEES ON STRENGTH, BY LEVEL, AND PERIOD

TABLE 1

MANPOWER STOCKS BY LEVEL, AND PERIOD

LEVEL		APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
PROG	NO.	9/73	8/69	8/70	10/77	8/84	5/79	5/69	10/78	13/73	12/81	10/82
	PERC.	12.3	11.6	11.4	13.0	9.5	6.3	7.2	12.8	17.8	14.8	12.2
SAI	NO.	18/73	11/69	9/70	13/77	15/84	16/79	13/69	9/78	8/73	16/81	18/82
	PERC.	24.7	15.9	12.9	16.9	17.9	20.3	18.8	11.5	11.0	19.8	22.0
SAII	NO.	20/73	21/69	17/70	17/77	16/84	17/79	13/69	19/78	12/73	15/81	11/82
	PERC.	27.4	30.4	24.3	22.1	19.0	21.5	18.8	24.4	16.4	18.6	13.4
SAIII	NO.	21/73	25/69	32/70	30/77	38/84	36/79	30/69	32/78	27/73	27/81	24/82
	PERC.	28.8	36.2	45.7	39.0	45.2	45.6	43.5	41.0	37.0	33.3	29.3
SAIV	NO.	5/73	4/69	4/70	7/77	7/84	5/79	8/69	8/78	13/73	11/81	19/82
	PERC.	6.8	5.8	5.7	9.1	8.3	6.3	11.6	10.3	17.8	13.6	23.2

Note: NO. represents the number of employees present at the individual level compared to total numbers present at the beginning of the period.
PERC. represents the same figure in percentage format.

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TABLE 2

MEAN AGES OF MANPOWER STOCKS, BY LEVEL AND PERIOD

LEVEL		APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
PROG	NO.	7/9	7/8	7/8	8/10	6/8	4/5	4/5	9/10	12/13	11/12	10/10
	MEAN	21.86	21.43	23.00	22.63	23.67	23.50	24.50	22.78	24.08	22.82	25.10
	S.D.	1.95	1.72	4.43	2.33	2.94	3.42	3.42	3.42	3.63	2.23	4.20
SAI	NO.	17/18	9/11	7/9	11/13	13/15	13/16	11/13	9/9	8/8	16/16	18/18
	MEAN	23.59	23.67	24.29	22.45	25.15	26.38	25.64	25.89	26.00	24.81	25.06
	S.D.	2.12	2.12	2.06	1.51	4.52	4.68	4.88	5.49	3.25	3.31	3.35
SAII	NO.	18/20	20/21	16/17	15/17	16/16	17/17	13/13	17/19	11/12	15/15	11/11
	MEAN	26.83	25.65	25.81	26.80	28.00	26.71	29.85	29.41	26.18	27.60	28.00
	S.D.	2.41	3.00	3.25	2.98	3.39	4.21	9.85	9.06	3.09	3.79	5.40
SAIII	NO.	18/21	22/25	27/32	27/30	33/38	34/36	29/30	32/32	27/27	27/27	24/24
	MEAN	29.83	29.59	29.48	29.37	29.67	30.00	30.59	30.06	32.30	30.74	31.58
	S.D.	4.79	5.21	4.96	5.14	5.09	4.85	5.17	5.49	8.12	7.71	7.68
SAIV	NO.	4/5	3/4	3/4	6/7	6/7	4/5	7/8	7/8	12/13	10/11	18/19
	MEAN	37.00	38.00	39.00	35.33	36.00	39.00	35.14	34.71	33.50	33.70	33.50
	S.D.	11.40	13.75	13.75	9.69	9.88	11.05	9.92	9.96	8.44	10.31	8.67

Note: Age is measured in years.
NO. indicates the number of employees for which data was available.
S.D. = standard deviation.

FINE PRINT

TABLE 3

MEAN LENGTH OF SERVICE OF MANPOWER STOCKS, BY LEVEL AND PERIOD

		APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
PROG	NO.	8/9	7/8	7/8	9/10	7/8	4/5	4/5	9/10	12/13	11/12	10/10
	MEAN	10.06	5.07	9.71	3.39	9.50	6.00	12.00	3.56	6.58	4.36	6.70
	S.D.	5.90	2.56	2.93	0.82	0.71	5.35	5.35	0.39	3.54	2.98	3.13
SAI	NO.	18/18	11/11	9/9	12/13	14/15	16/16	13/13	9/9	8/8	16/16	18/18
	MEAN	16.50	17.00	20.50	15.71	16.64	12.00	15.12	13.50	15.44	11.38	13.03
	S.D.	11.03	12.82	16.51	9.44	11.60	7.71	6.46	7.91	10.11	9.06	6.35
SAII	NO.	19/20	20/21	17/17	17/17	16/16	17/17	13/13	19/19	12/12	15/15	11/11
	MEAN	16.47	22.70	17.53	21.32	22.16	28.41	26.31	23.08	30.08	15.23	24.18
	S.D.	8.45	6.96	14.10	17.02	19.45	15.86	13.51	13.56	16.04	19.17	22.45
SAIII	NO.	20/21	24/25	30/32	30/30	38/38	36/36	30/30	32/32	27/27	27/27	24/24
	MEAN	24.80	30.60	31.53	36.93	34.92	47.39	44.62	48.31	48.85	43.39	36.02
	S.D.	17.50	16.77	18.20	17.31	19.37	35.23	22.05	22.32	27.11	27,51	30.87
SAIV	NO.	5/5	4/4	4/4	7/7	7/7	5/5	8/8	8/8	13/13	11/11	19/19
	MEAN	48.20	48.25	54.25	48.93	54.93	59.00	58.13	66.31	57.96	73.32	63.11
	S.D.	25.47	25.07	25.07	28.71	28.71	34.01	28.61	39.13	30.75	27.74	34.49

Note: Length of service is measured in months.
NO. indicates the number of employees for which data was available.
S.D. = standard deviation.

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Although mean ages of employees fluctuate somewhat from one period to the next, the overall change is not great. (See Figure 12.) The mean age of Systems Analyst IV's has dropped, but since the numbers of S.A. IV's have changed considerably over the total period, the change in age may be due only to larger sample numbers.

A graph of the mean length of service of manpower stocks shows some patterns emerging. (See Figure 13.) Programmers show a zigzag pattern that might be attributed to regular promotions out of the Programmer level into the Systems Analyst series. Most programmers commence in the April-September period, and are eligible for promotion one year later. A combination of new employees entering, and experienced people leaving during the April-September period would cause the mean length of service measurement to drop during that interval. In contrast, the October to March interval shows less movements, and therefore the length of service measurement increases. This is one area where yearly summaries of data are more likely to be appropriate.

The zigzag pattern show for the programmer level is shown to a lesser degree by Systems Analyst I's. Although seasonal recruitment and promotions occur in this level as well, the fluctuations are dampened by the presence of employees who have entered the level through promotion from a Programmer position. The presence of Systems Analyst I's with previous experience as a programmer offsets the lack of experience of new recruits entering at that level.

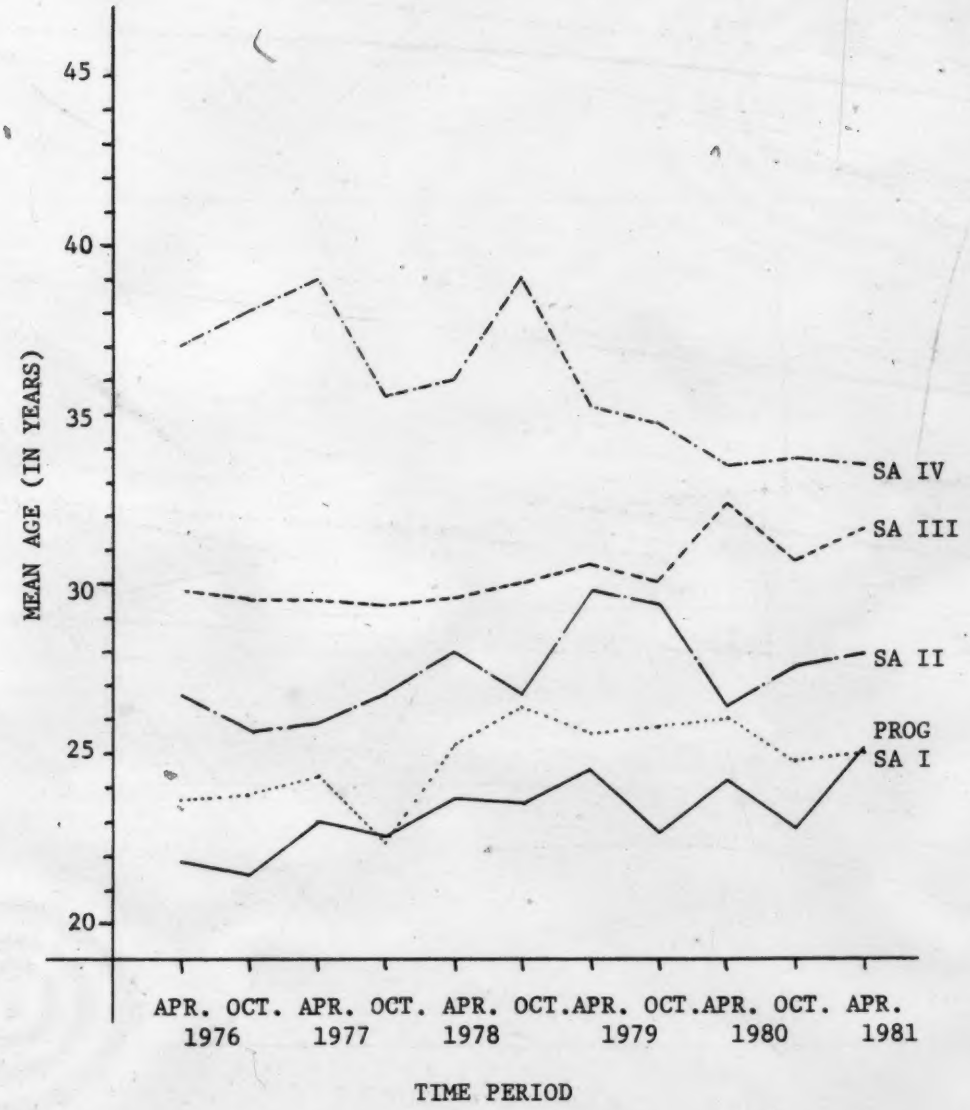

FIGURE 12. MEAN AGE OF EMPLOYEES ON STRENGTH, BY LEVEL AND PERIOD

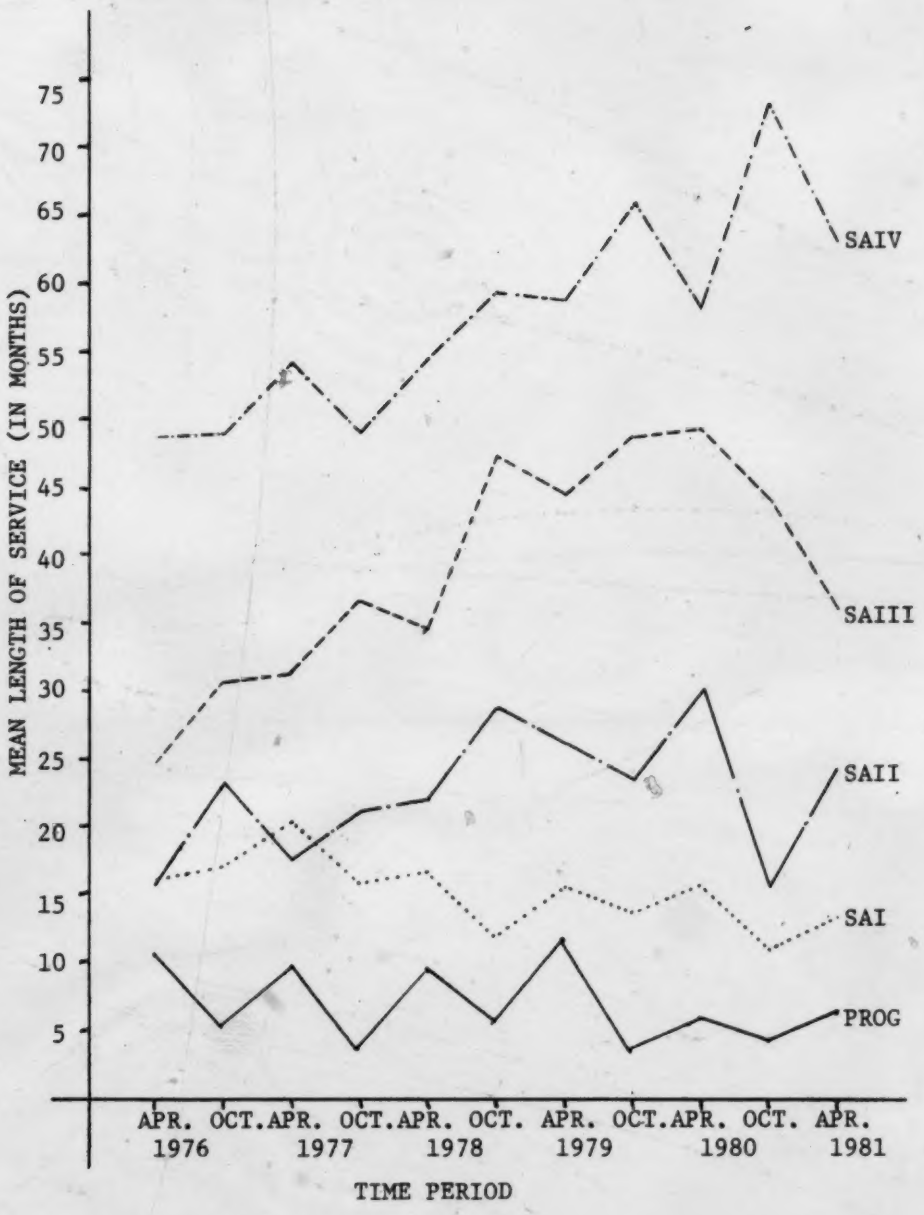

FIGURE 13. MEAN LENGTH OF SERVICE OF MANPOWER STOCKS, BY LEVEL AND PERIOD

Variations in length of service of Systems Analyst II's, III's, and IV's are less regular. The drop in mean length of service of SA II's in 1980 can be attributed to an influx of seven British recruits. All seven recruits were promoted to the Systems Analyst III level during October 1980, to March, 1981, which caused a drop in the mean length of service of the Systems Analyst III's and a rise in the mean length of service of the Systems Analyst II's.

Systems Analyst III's showed an increase in mean length of service for most of the total period, as did Systems Analyst IV's. This may suggest a pooling or stagnation of experienced analysts at these levels. The different policies affecting promotions out of these two levels appear to have exerted a noticeable restraint on the employees in these categories until 1980 when British recruits were admitted to the work force, and the numbers of Systems Analyst IV positions increased. Figure 14 indicates that the composition of manpower stocks in relation to recruitment source have changed considerably over the period of the study. For the first three years, the biggest proportion of employees have been recruited through open competition. For the latter part of the time period, stocks originating from that source dropped off considerably in proportion to those originating from school recruitment. The influx of British recruits is also noticeable.

Table 4 indicates the educational qualifications of manpower stocks throughout the period of the study. Despite

TABLE 4

MEAN COMPOSITON OF MANPOWER STOCKS, BY EDUCATION AND PERIOD

	APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
DIPLOMA	.26	.33	.30	.30	.27	.28	.30	.40	.37	.41	.40
DEGREE	.37	.32	.31	.31	.31	.33	.36	.35	.33	.31	.32
COURSES	.25	.22	.24	.26	.30	.30	.26	.21	.26	.26	.26
UNKNOWN	.12	.13	.14	.13	.12	.09	.07	.05	.04	.02	.02

Note: Proportions are relative to total employees on strength during each period.

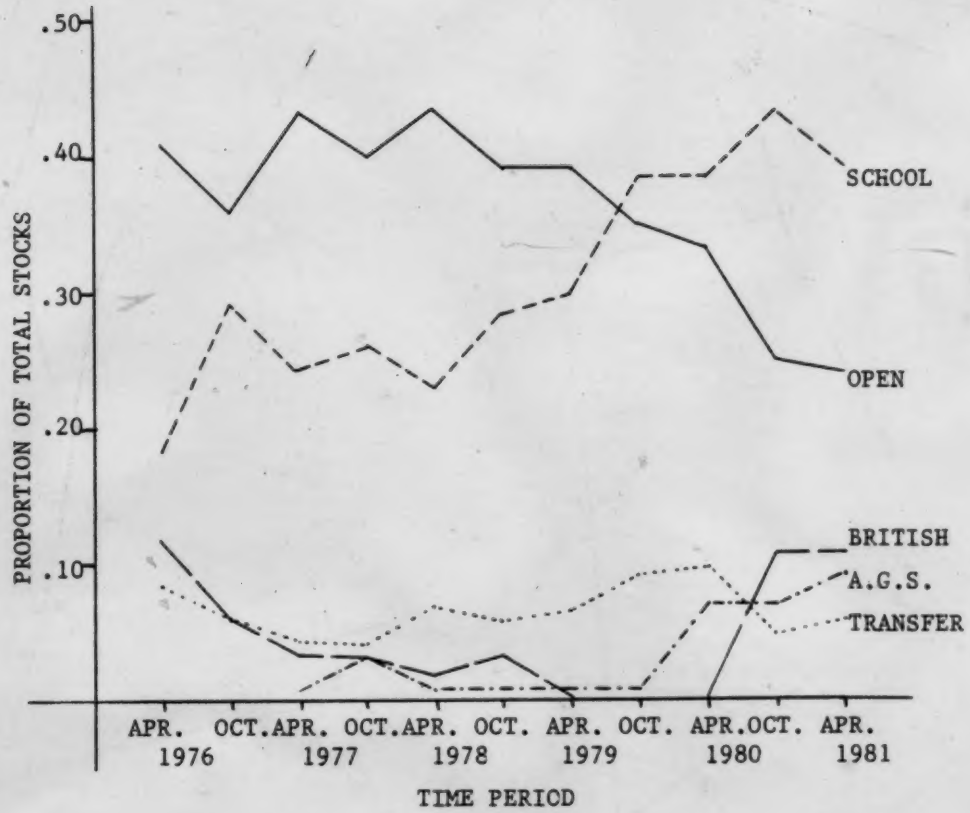

FIGURE 14. COMPOSITION OF MANPOWER STOCKS, BY SOURCE AND PERIOD

the changing proportions of levels of employees, and the changing emphasis on specific sources of recruitment, educational qualifications have varied little over the period of the study. The fluctuations might be affected more by the proportions of employees with unknown educational qualifications than be any other factor.

Table 5 gives a breakdown of qualifications by grade. Employees holding diplomas are most visible at the programmer level, where active recruitment occurs. Degree holders drop in proportion slightly as grade increases until the Systems Analyst IV level where there is an increase in proportions of those holding degrees. The jump is both within the grade series and relative to other education levels.

Table 17 shows that proportions of males to females increases as grade rises, until the Systems Analyst IV level where the trend reverses. Overall, the proportions of males to females has dropped slightly during the period of the study. (Figure 22.)

4.0.2 Recruitment

Recruitment was analyzed primarily in terms of sources of incoming employees, and volume of incoming employees. Sources of employees were divided into six mutually exclusive categories, as follows:

1. OPEN COMPETITION. This category included any non-government employee who entered AGS through regular

TABLE 5

MEAN COMPOSITION OF MANPOWER STOCKS, BY GRADE AND EDUCATION

	DIPLOMA	DEGREE	COURSES	UNKNOWN
	MEAN S.D.	MEAN S.D.	MEAN S.D.	MEAN S.D.
PROG.	.62 (.16)	.03 (.05)	.20 (.11)	.15 (.06)
SAI	.35 (.08)	.39 (.13)	.14 (.07)	.10 (.09)
SAII	.30 (.07)	.36 (.12)	.28 (.15)	.05 (.05)
SAIII	.30 (.11)	.33 (.09)	.31 (.08)	.07 (.06)
SAIV	.16 (.10)	.43 (.12)	.26 (.08)	.15 (.07)

Note: Mean figures represent a mean of the proportions of employees at that classification level relative to the total numbers of employees on strength for each period of the study.

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ongoing recruitment activities (as opposed to specialized school or overseas recruitment programs).

2. SCHOOL RECRUITMENT. This category included only students hired through formal recruitment programs conducted through manpower centers at universities and technical schools. Students who applied directly to AGS and were interviewed as part of the regular ongoing recruitment activities were considered to have entered AGS through the open competition route.
3. BRITISH RECRUITMENT. This category was only for employees hired through campaigns conducted in Great Britain.
4. TRANSFERS WITHIN ALBERTA GOVERNMENT SERVICES. Alberta Government Services employees who entered the Systems Group from other parts of the department qualified for this category. Examples of sources included the Technical Support Group from the Data Center, and the Planning and Policy Branch. Project clerks entering the programmer-analyst series were also considered to belong to this category.
5. TRANSFERS FROM GOVERNMENT DEPARTMENTS OTHER THAN AGS. Personnel who laterally transferred or were promoted to Systems Group positions from other government departments were included in this category. Boards and commissions were not considered to be departments, and therefore employees from these sources were considered to have entered AGS through the open competition route.

6. UNKNOWN.

The categories were chosen to represent recruitment programs that were independent of one another, so that the relative impact of each program could be evaluated.

Figure 15 represents an analysis of levels and sources of employees recruited during each of the six-month periods of the study. There were 150 commencements from April, 1976, to September, 1981, inclusive. Employees recruited through school programs almost always commenced during the April to September months, whereas employees entering through open competition provided a larger number of the commencements occurring during the months of October to March. The seasonal variation in sources is reflected by a comparable variation in the classification levels of the employees hired. Periods of high school recruitment show large numbers of Programmers and Systems Analyst I's commencing. Periods of greater open recruitment show larger numbers of employees commencing at the Systems Analyst II and III levels. During the entire period of the study, only four employees commenced at the Systems Analsyt IV level. Since April, 1977, the number of commencements was always higher in April to September periods than October to March periods.

Each level of employee tended to originate from one source more than others. Figure 16 shows a breakdown of the 150 commencements, by classification level and source. Of the 59 Programmers that commenced, 42 entered through school recruitment programs. Forty System Analyst I's commenced; 28

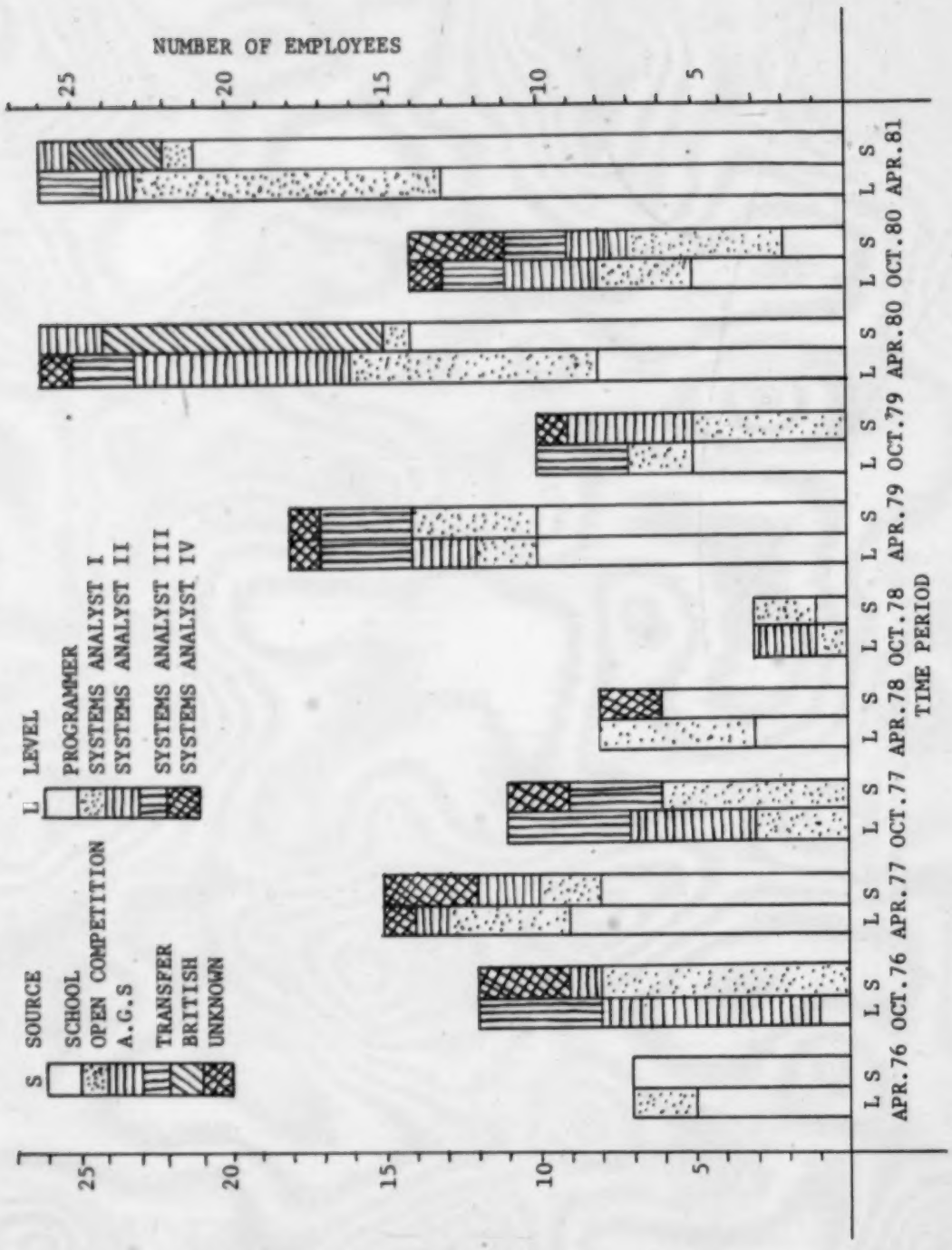

FIGURE 15. NUMBERS OF EMPLOYEES COMMENCED, AND SOURCE, BY PERIOD

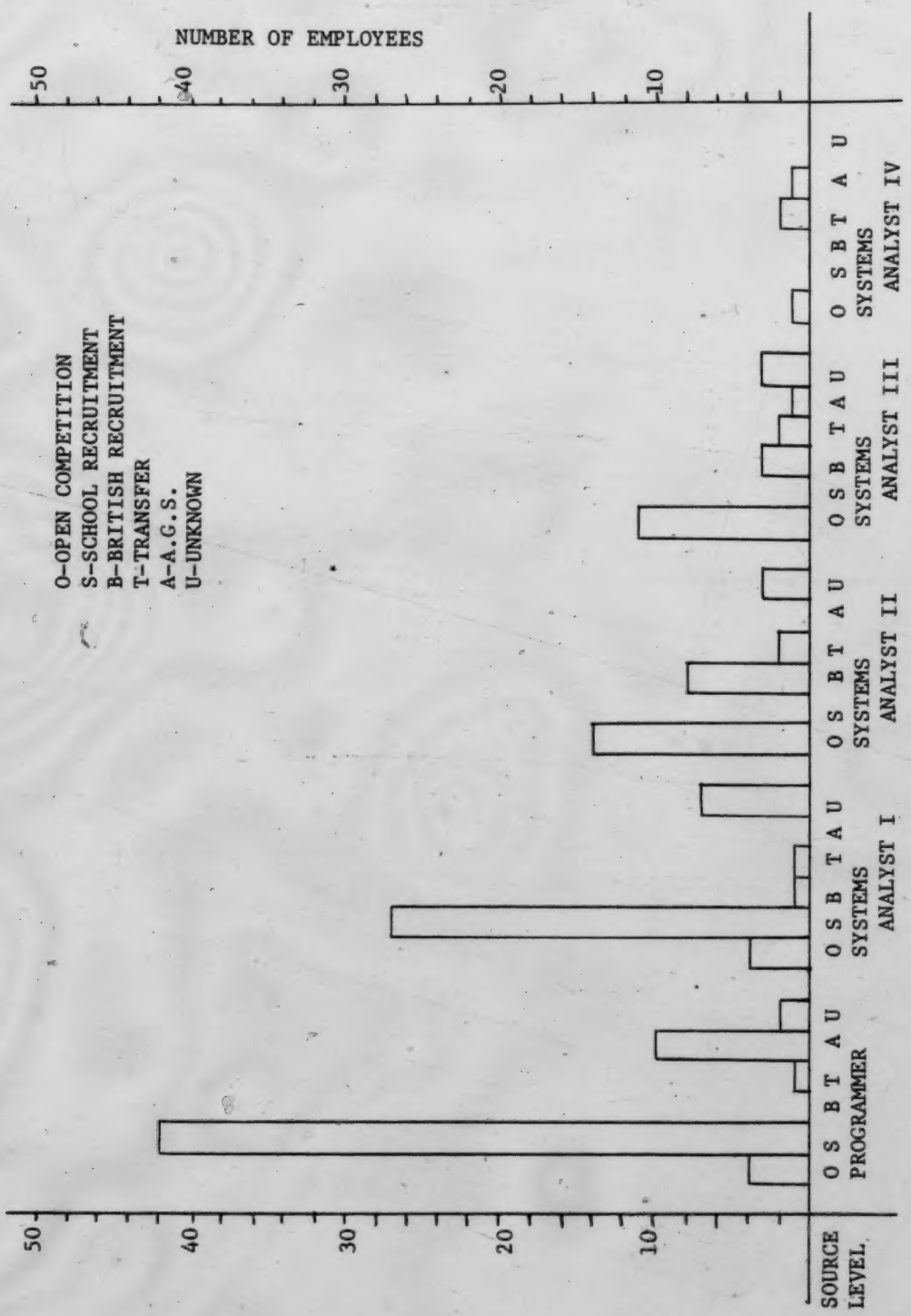

FIGURE 16. TOTAL COMMENCEMENTS, BY LEVEL AND SOURCE

of whom entered through school recruitment. Of the 27 Systems Analyst II's that commenced, 14 entered through open competition. Eleven of 20 Systems Analyst III's were recruited through open competition. Two out of four Systems Analyst IV's transferred in from other provincial government departments. Alberta Government Services provided a strong secondary source of programmers, and British recruitment provided a good secondary source of Systems Analyst II's.

The average age of the recruits commencing increases as the classification level increases. (Table 6.) The differences between one level and the next is in the order of one to two years, except in the case of the difference between Systems Analyst II's and III's, which is almost six years. Age distribution of employees commencing as Programmers and Systems Analyst I's are skewed left, while Systems Analyst II's and III's show a more symmetric distribution. (Figure 17.) This may be partially explained by the emphasis on school recruitment of Programmers and S.A. I's as opposed to recruitment of S.A. II's and III's through more open markets. Systems Analyst IV's show no distinctive pattern, but the category has only a small sample size, and the results would not provide as meaningful a comparison.

The proportions of males to females increases steadily as the classification level increases, (Table 7) until reaching the Systems Analyst IV level. Again, the small numbers of Systems Analyst IV's prevent the data for that level from being equally useful in the analysis.

TABLE 6

AGE CHARACTERISTICS OF COMMENCEMENTS, BY LEVEL

LEVEL	TOTAL COMMENCED	PERCENT OF TOTAL	MEAN AGE	STANDARD DEVIATION
PROG	59 (58)	39.33	23.12	3.79
SAI	40 (37)	26.67	24.49	4.04
SAII	27 (26)	18.00	30.15	7.43
SAIII	20 (18)	13.33	30.89	4.55
SAIV	4 (4)	2.67	32.50	9.33

Note: Age is measured in years.
Number in brackets indicates the number of employees for which data was available.
Percent of total represents the total commencements at each level in proportion to the sum of all commencements during the five and one-half year period of the study.

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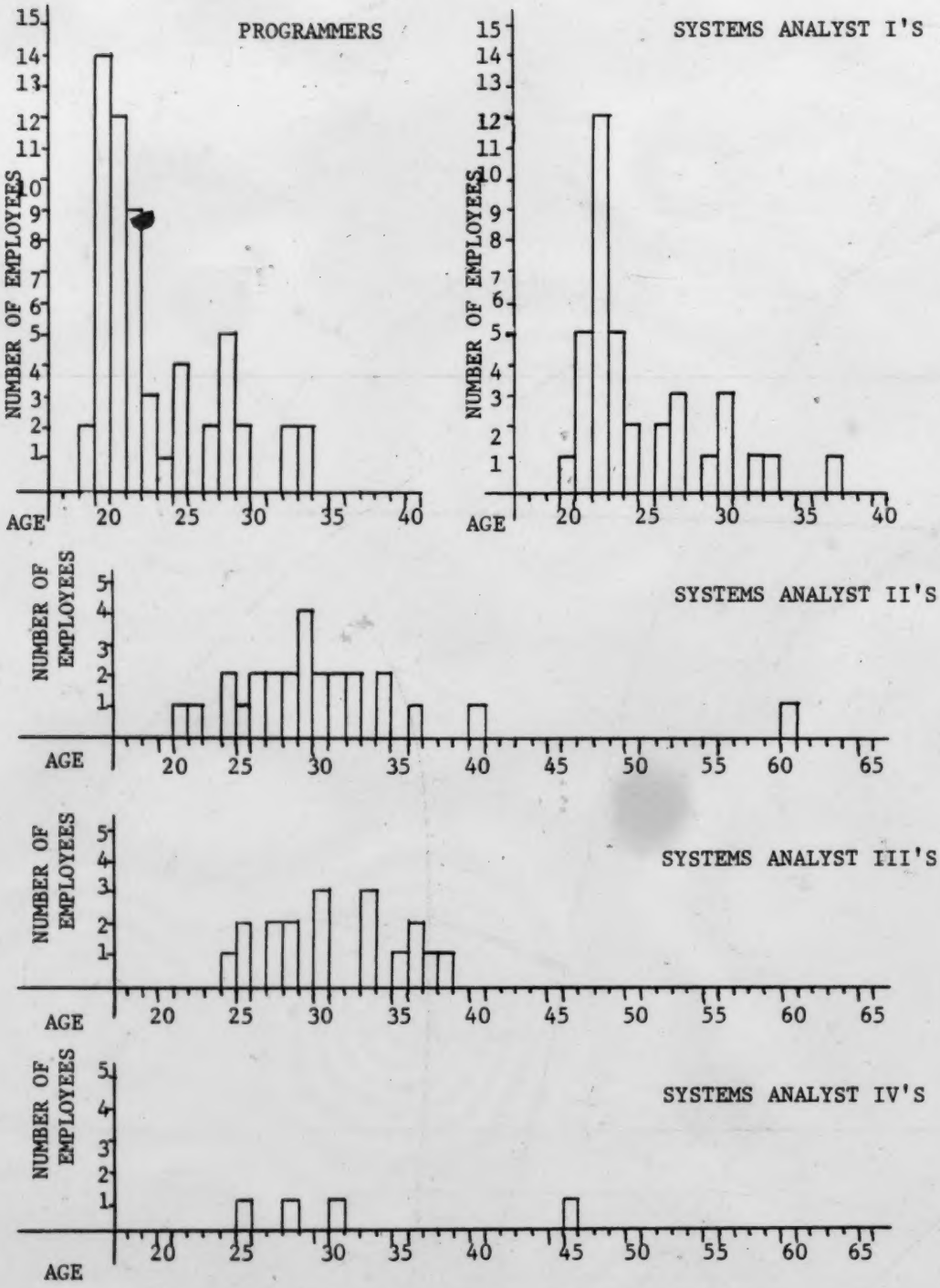

FIGURE 17. AGE DISTRIBUTION OF EMPLOYEES AT COMMENCEMENT

TABLE 7

COMMENCEMENTS, BY LEVEL AND SEX

LEVEL	MALE NO.	MALE PERC.	FEMALE NO.	FEMALE PERC.	UNKNOWN NO.	UNKNOWN PERC.	TOTAL
PROG	26	(44.1)	33	(55.9)			59
SAI	24	(60.0)	15	(37.5)	1	(2.5)	40
SAII	19	(70.4)	7	(25.9)	1	(3.7)	27
SAIII	18	(90.0)	2	(10.0)			20
SAIV	3	(75.0)	1	(25.0)			4

Note: NO. represents the number of employees.
PERC. represents the percent of total employees at that level.

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4.0.3 Internal Movements

Internal movements include promotions to a higher grade, demotions to a lower grade, and transfers from one branch to another at the same grade. No demotions occurred during the period of the study. Table 8 shows that lateral transfer movements were small relative to the total population. Thirty eight lateral transfers in total took place during the period of the study, almost half of which were at the System Analyst III level. It might be postulated that transfers were more common at that level because promotions became more difficult to obtain due to restrictions on Systems Analyst IV position.

A total of 175 promotions occurred during the period of the study (Table 9) within the programmer analyst series. (Figures also show that twelve Systems Analyst IV's were promoted out of the analyst series. These were included only for the sake of comparison since they are technically considered to be terminations out of the series.) Age data and length of service data by level (Tables 10 and 11) do not show any significant patterns, although this might be attributed to the small numbers of occurrences.

Proportions of males to females increases as the grade increases until the Systems Analyst IV level, where the trend reverses, (Table 12), in much the same manner as proportions varied for manpower stocks.

Data depicting the educational qualifications of employees promoted (Table 13) show that degree holders, and

TABLE 8

NUMBERS OF EMPLOYEES LATERALLY TRANSFERRED, BY LEVEL AND PERIOD

		APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
PROG	NO.	1/9	1/8				1.5					
	PERC.	0.11	0.13				0.20					
SAI	NO.	1/18		1/9		1/15			1/9			
	PERC.	0.06		0.11		0.07			0.11			
SAII	NO.	3/20				2/16	1/17		1/19			
	PERC.	0.15				0.13	0.06		0.05			
SAIII	NO.	3/21	2/25	3/32	1/30		1/36	2/30	2/32	3/27		1/24
	PERC.	0.14	0.08	0.09	0.03		0.03	0.07	0.06	0.11		0.04
SAIV	NO.	1/5						2/8	2/8			1/19
	PERC.	0.20						0.25	0.25			0.05
TOTAL	NO.	9/73	3/69	4/70	1/77	3/84	3/79	4/69	6/78	3/73	0/81	2/82
	PERC.	0.12	0.04	0.06	0.01	0.04	0.04	0.06	0.08	0.04	0.00	0.02

Note: No. and indicate the number of employees laterally transferred during a period relative to the total number of employees on strength at that classification level at the beginning of the period.
PERC. represents the same figure in percentage format.

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TABLE 9

NUMBERS OF EMPLOYEES PROMOTED, BY LEVEL AND PERIOD

		APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
PROG	NO.	5/9	1/8	6/8	1/10	6/8	0	4/5	1/10	7/13	4/12	5/10
	PERC.	0.56	0.13	0.75	0.10	0.75		0.80	0.10	0.54	0.33	0.50
SAI	NO.	10/18	2/11	5/9	1/13	8/15	3/16	10/13	2/9	5/8	2/16	7/18
	PERC.	0.56	0.18	0.56	0.08	0.53	0.19	0.77	0.22	0.63	0.13	0.39
SAII	NO.	6/20	8/21	3/17	5/17	4/16	4/17	5/13	4/19	8/12	7/15	1/11
	PERC.	0.30	0.38	0.18	0.29	0.25	0.24	0.38	0.21	0.67	0.47	0.09
SAIII	NO.			2/32			3/36	2/30	5/32	4/27	7/27	2/24
	PERC.			0.06			0.08	0.03	0.16	0.15	0.26	0.08
SAIV	NO.	1/5				1/7		3/8		4/8		3/19
	PERC.	0.20				0.14		0.38		0.31		0.16
TOTAL	NO.	21/73	11/69	16/70	7/77	18/84	10/79	21/69	12/78	24/73	20/81	15/82
	PERC.	0.29	0.16	0.23	0.09	0.21	0.13	0.30	0.15	0.33	0.25	0.18

Note: NO. indicates the number of employees promoted to a higher classification during a period, relative to the number of employees on strength at the source classification level at the beginning of the period.
Numbers at the SAIV level indicate the number of analysts promoted to a senior officer position (technically considered a termination).
PERC. represents the same figures in percentage format.

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TABLE 10

MEAN AGES OF EMPLOYEES PROMOTED, BY LEVEL AND PERIOD

		APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
PROG	NO.	4/5	1/1	6/6	1/1	5/6	0	4/4	1/1	6/6	4/4	5/5
	MEAN	21.00	25.00	21.50	28.00	22.60		24.50	30.00	22.83	23.75	23.40
	S.D.	0.82	0.00	0.84	0.00	1.95		3.42	0.00	2.71	1.71	3.21
SAI	NO.	9/9	2/2	4/5	1/1	7/8	3/3	8/10	2/2	5/5	2/2	7/7
	MEAN	23.00	25.00	25.00	26.00	22.86	26.00	24.88	31.00	24.60	27.50	24.71
	S.D.	2.35	0.00	2.16	0.00	1.21	4.36	2.90	11.31	3.13	4.95	3.68
SAII	NO.	7/7	7/8	3/3	4/5	4/4	4/4	5/5	4/4	8/8	7/7	1/1
	MEAN	26.57	27.29	24.67	26.75	28.25	29.25	24.20	39.25	27.38	30.14	27.00
	S.D.	3.31	2.14	3.79	3.59	1.71	4.43	1.64	15.11	3.29	1.95	0.00
SAIII	NO.	2/3	0	2/2	0	0	3/3	2/2	5/5	4/4	7/7	2/2
	MEAN	32.00		32.50			29.00	30.00	30.80	32.00	30.43	30.00
	S.D.	7.07		0.71			2.00	1.41	5.12	8.52	3.51	2.83

Note: Age is measured in years.
NO. indicates the number of employees for which data was available. (Zeroes indicate no observations for the period).
S.D. = standard deviation.

TABLE 11

MEAN LENGTH OF SERVICE OF EMPLOYEES PROMOTED, BY LEVEL AND PERIOD

		APR76	OCT76	APR77	OCT77	APR78	OCT78	APR79	OCT79	APR80	OCT80	APR81
PROG	NO.	5/5	1/1	6/6	1/1	6/6	0	4/4	1/1	6/6	4/4	5/5
	MEAN	14.20	12.50	12.83	7.50	12.00		15.00	7.00	12.25	10.50	12.00
	S.D.	5.33	0.00	2.04	0.00	0.32		6.00	0.00	0.27	3.00	0.00
SAI	NO.	9/9	2/2	5/6	1/1	7/8	3/3	10/10	2/2	5/5	2/2	7/7
	MEAN	21.28	18.25	26.60	24.50	24.00	15.00	19.70	18.00	19.20	12.50	20.79
	S.D.	9.17	8.84	19.84	0.00	12.00	4.77	5.66	8.49	6.57	9.19	6.01
SAII	NO.	7/7	7/8	3/4	5/5	4/4	4/4	5/5	4/4	8/8	7/7	1/1
	MEAN	24.07	23.29	31.33	21.40	29.25	21.25	33.70	21.25	32.75	6.00	84.00
	S.D.	11.10	5.07	6.05	12.89	24.35	6.17	5.43	6.17	12.39	0.00	0.00
SAIII	NO.	2/3	0	2/2	0	0	3/3	2/2	5/5	4/4	7/7	2/2
	MEAN	36.00		45.50			44.00	42.75	40.90	58.88	40.71	36.25
	S.D.	1.41		25.46			17.02	33.59	15.54	17.30	30.29	15.91

Note: Length of service is measured in months.
NO. indicates the number of employees for which data was available. (Zeroes indicate no observations for the period).
S.D. = standard deviation

TABLE 12

PROPORTIONS OF PROMOTIONS, BY GRADE AND SEX

	MALES		FEMALES		RATIO
	NO.	PROPORTION	NO.	PROPORTION	
PROG.	21	0.53	19	0.37	1.11
SAI	30	0.54	26	0.46	1.15
SAII	38	0.68	18	0.32	2.11
SAIII	22	0.81	5	0.19	4.40
SAIV	9	0.75	3	0.25	3.00

Note: Proportions are calculated by dividing the numbers promoted at that level by the total numbers of promotions. The ratio is the numbers of males promoted over the numbers of females promoted, at that level.

TABLE 13

PROPORTIONS OF PROMOTIONS, BY GRADE AND EDUCATION

	DIPLOMA	DEGREE	COURSES	UNKNOWN
PROG	.73	.05	.18	.05
SAI	.41	.39	.13	.07
SAII	.34	.32	.30	.04
SAIII	.22	.44	.26	.07
SAIV	.17	.58	.25	.00

Note: Proportions were derived by taking the numbers promoted (while holding specific qualifications) over total numbers promoted at that level.

employees with various courses formed greater proportions of employees promoted as the classification level increased. Employees with diplomas were decreasingly represented at hhigher levels.

Table 14 shows that employees entering the system through open competitions formed a larger part of the promotions as the grade level increased whereas employees recruited through school recruitment were represented in decreasing proportions. This may be partly explained by the fact that employees recruited through open competitions were more likely to enter at a higher grade in the beginning, whereas school recruits always entered at the programmer or Systems Analyst I level.

TABLE 14

PROPORTIONS OF PROMOTIONS, BY GRADE AND SOURCE

	OPEN	SCHOOL	BRITISH	TRANSFER	A.G.S.	UNKNOWN
PROG	.10	.70	.00	.00	.10	.10
SAI	.11	.64	.04	.02	.00	.20
SAII	.39	.25	.14	.05	.00	.16
SAIII	.41	.22	.04	.11	.04	.19
SAIV	.58	.17	.00	.08	.00	.17

Note: Proportions were derived by taking the numbers originating from a specific source that were promoted at that level over total numbers promoted at that level.

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4.0.4 Terminations

Terminations were analyzed primarily in terms of volumes of outgoing employees and their destinations. Reasons for termination were divided into seven mutually exclusive categories:

1. EMPLOYMENT REASONS.
   a. Promotion to Management Position (Senior Officer position) within the Systems Group.
   b. Transfer or promotion to a non-Systems Group position within Alberta Government Services.
   c. Transfer or promotion to a position in a provincial government department other than AGS. (This did not include transfers or promotions to boards and commissions; these movements are considered to be part of category (d) since boards and commissions are not administered as part of the regular provincial government structure.)
   d. Acceptance of employment outside of the Alberta Government.
2. FAMILY REASONS. This category included employees terminating because of their spouse's transfer to another geographical location, or an employee deciding to stay home to care for children,.
3. PERSONAL REASONS. This category included employees who terminated work to return to school full-time, employees who terminated for health reasons, and employees who terminated without other employment

already arranged.

4. UNKNOWN.

The categories were chosen by considering factors that would be under varying degrees of employer control. For example, an employer would not have a lot of control over the transfer of a spouse, but an employer might have control over job conditions that might be major factors behind an employee's decision to take a job assignment elsewhere.

A total of 130 terminations occurred over the five and one-half year period of the study. A breakdown of terminations by time period reveals no particular patterns (Figure 18), although numbers terminating each period varied less than the numbers commencing each period. [22]

A breakdown of terminations by level and destination showed that other employment became increasingly dominant as a termination destination for levels up to and including Systems Analyst III's. (Figure 19) Systems Analyst IV's most often left the analyst series by promotion into a management position in Alberta Government Services.

The mean age and mean length of service of departing employees increased as the classification level increased (Table 15), which could be reasonably expected. Ages of employees departing from a particular level, however, were much more consistent than the length of service of the

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[22] Mean commencements per six-month period equalled 13.64 with a standard deviation of 7.34. Mean terminations per six-month period equalled 11.82 with a standard deviation of 3.84.

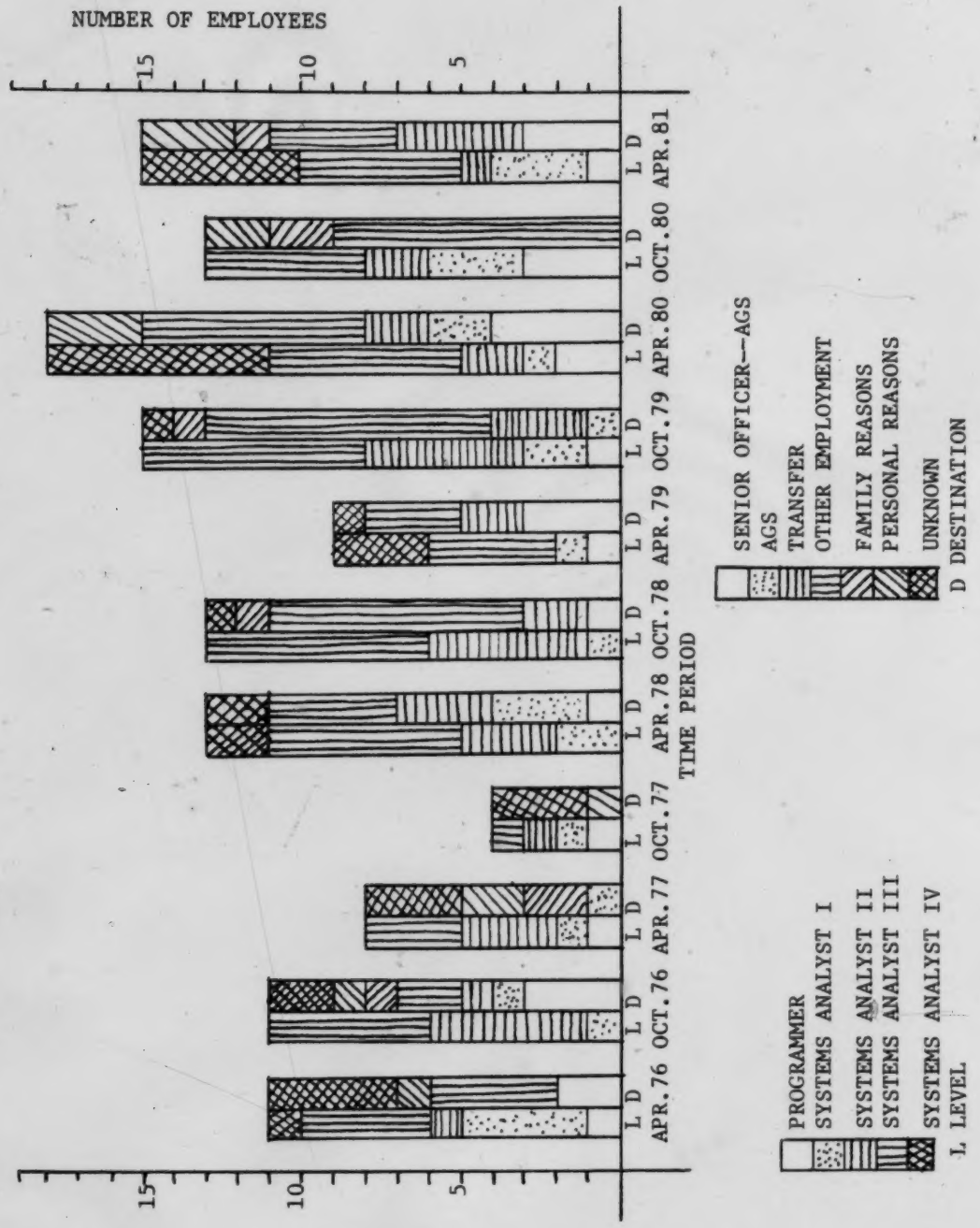

FIGURE 18. NUMBERS OF EMPLOYEES TERMINATED, BY LEVELS AND DESTINATIONS, BY PERIOD

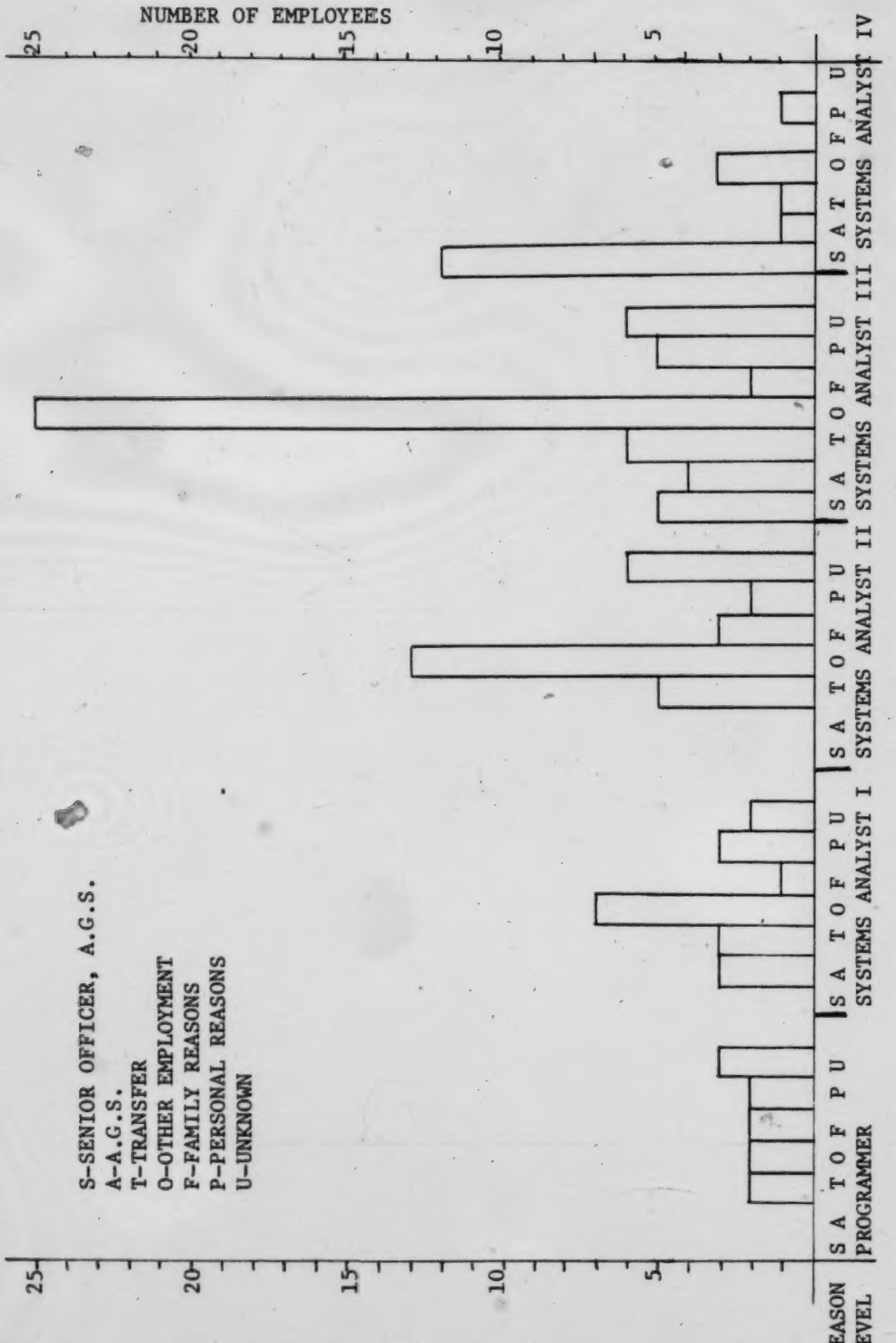

FIGURE 19. EMPLOYEES TERMINATING, BY LEVEL AND DESTINATION

TABLE 15

AVERAGE AGE AND LENGTH OF SERVICE CHARACTERISTICS OF TERMINATIONS, BY LEVEL

LEVEL	TOTAL TERMIN.	DATA AVAIL.	PERCENT OF TOTAL	MEAN AGE	STD. DEV.	MEAN L.O.S.	STD. DEV.
PROG	11	10/10	8.46	25.20	4.78	7.95	5.62
SAI	19	17/18	14.62	25.12	3.06	17.81	9.78
SAII	29	25/28	22.31	26.44	4.24	26.79	14.44
SAIII	53	46/51	40.77	29.85	4.73	40.76	22.49
SAIV	18	17/18	13.85	31.24	3.03	57.19	27.35

Note: Age is measured in years.
L.O.S. = length of service (in months)
STD. DEV. = standard deviation
The first figure in the Data Avail. column indicates the number of employees for which age data was available; the second figure indicates the number of employees for which length of service data was available.
Percent of total represent the total terminations at each level in proportion to the sum of all terminations during the five and one-half year period.

employees especially at the Systems Analyst III and IV levels. (Figures 20 and 21) Proportions of males and females varied from level to level in no apparent pattern (Table 16).

Terminations can be compared back to commencements to get additional perspective on how these flows might be affecting the Systems Group. Figure 22 shows that females contributed increasingly to commencements compared to males during the most recent four years, especially relative to their proportion within total manpower stocks. In addition, they tend to form a smaller part of the terminations. The net effect is an overall increase in the proportions of females to males.

The ratio of commencements to terminations overall is 150/130 or 1.15. Table 17 indicates that diploma holders have the highest ratio of commencements to terminations, both compared to other educational designations, and to the average ratio. Degree holders have a sligher lower ratio than average. A comparison of commencements to terminations of the basis of recruitment source shows more striking differences (Table 18). Employees recruited from within A.G.S. show a high ratio of commencments to terminations while employees recruited through open competition or transfers are more likely to leave than to enter. For an organization concerned with retention of employees, it may be worthwhile to evaluate the success of recruitment programs through the use of figures such as these.

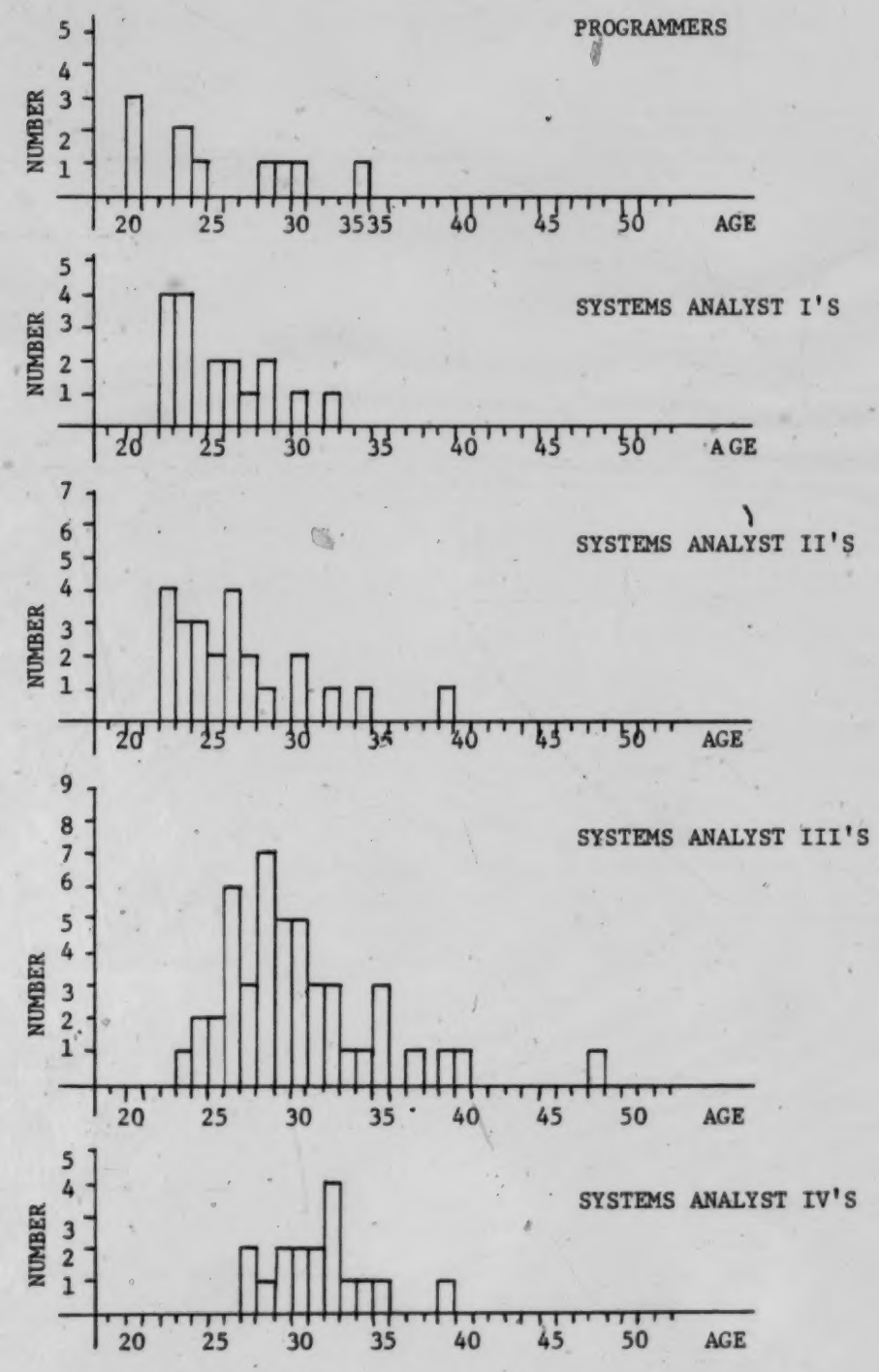

FIGURE 20. AGE DISTRIBUTION OF TERMINATIONS, BY LEVEL

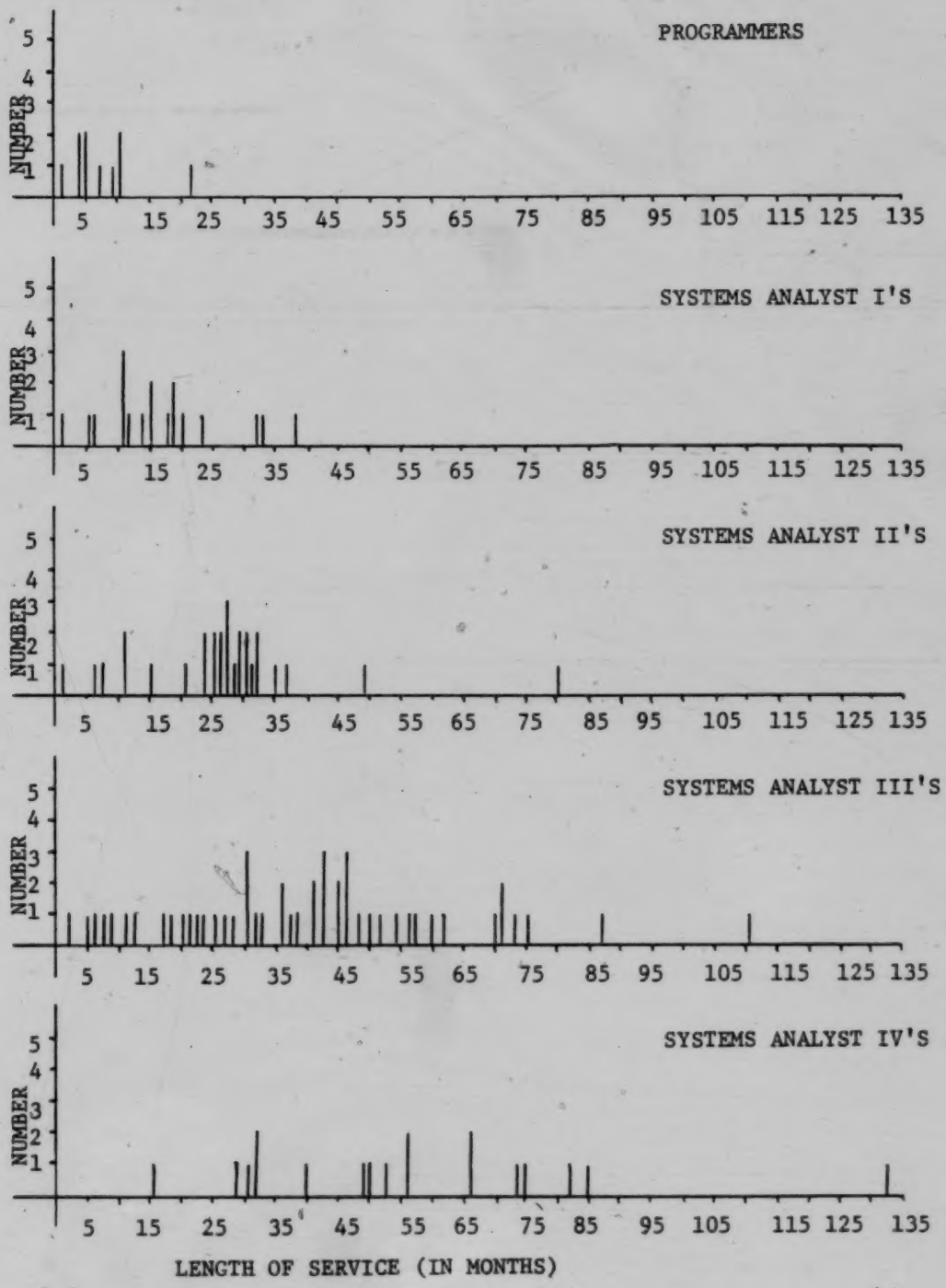

FIGURE 21. LENGTH OF SERVICE DISTRIBUTION OF TERMINATING EMPLOYEES, BY LEVEL

TABLE 16

TERMINATIONS, BY LEVEL AND SEX

LEVEL	[redacted] PERC.	FEMALE NO. PERC.	UNKNOWN NO. PERC.	TOTAL NUMBER
PROG	6 (54.6)	5 (45.5)		11
SAI	16 (84.2)	2 (10.5)	1 (5.3)	19
SAII	16 (55.2)	13 (44.8)		29
SAIII	42 (79.2)	10 (18.9)	1 (1.9)	53
SAIV	13 (72.2)	5 (27.8)		18

Note: PERC. represents the proportion relative to total numbers that terminated at that level.

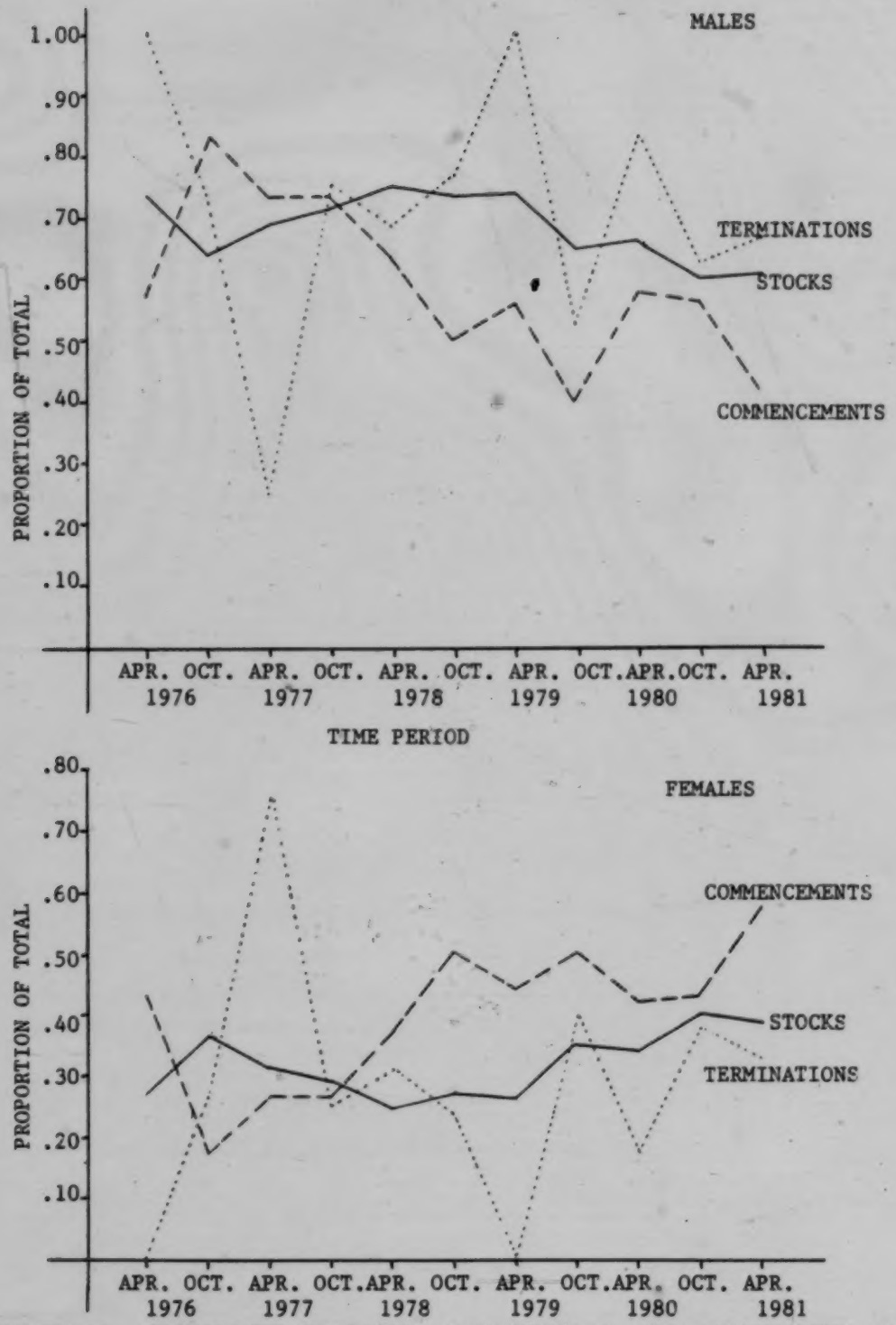

FIGURE 22. PROPORTIONS OF STOCKS, COMMENCEMENTS, AND TERMINATIONS, BY SEX

TABLE 17

PROPORTIONS OF COMMENCEMENTS AND TERMINATIONS, BY EDUCATION

	COMMENCE		TERMIN.		RATIO
	NO.	PROPOR.	NO.	PROPOR.	
DIPLOMA	56	.37	35	.27	1.60
DEGREE	48	.32	45	.35	1.07
COURSES	39	.26	33	.25	1.18
UNKNOWN	7	.05	17	.13	0.41

Note: PROPOR. represents the proportion of the numbers commencing or terminating (while holding a specific set of qualifications) relative to the total numbers of commencements or terminations that occurred during the period of the study. The RATIO is calculated by dividing the numbers of commencements by the number of terminations.

TABLE 18

PROPORTIONS OF COMMENCEMENTS AND TERMINATIONS, BY RECRUITMENT SOURCE

	COMMENCE		TERMIN.		RATIO
	NUMBER	PROPOR.	NUMBER	PROPOR.	COMM/TERM
OPEN	34	.23	45	.35	.76
SCHOOL	69	.46	32	.25	2.16
BRITISH	12	.08	10	.08	1.20
TRANSFER	8	.05	9	.07	.89
A.G.S.	12	.08	4	.03	3.00
UNKNOWN	15	.10	30	.23	0.50

Note: PROPOR. represents the proportions of numbers commencing or terminating over the total numbers of commencements or terminations that occurred during the period of the study. The RATIO is calculated by dividing the numbers of commencements by the number of of terminations.

TABLE 19

PROPORTIONS OF STOCKS, COMMENCEMENTS AND TERMINATIONS, BY SEX AND GRADE

	STOCKS		COMMENCE		TERMIN.	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
PROG	.62 (.26)	.36 (.26)	.42	.58	.45	.55
SAI	.64 (.19)	.36 (.19)	.60	.37	.84	.11
SAII	.67 (.14)	.33 (.14)	70	.30	.59	.41
SAIII	.77 (.06)	.23 (.06)	.90	.10	.77	.23
SAIV	.71 (.13)	.29 (.13)	.75	.25	.72	.28

Note: Proportions of stocks were taken for each of eleven periods and a mean proportion calculated. Numbers in brackets for stocks indicate standard deviations.
Proportions for commencements and terminations were calculated relative to overall totals during the period of the study.

5. SIMULATIONS

A variety of models have been developed to simulate the behaviour of manpower pools. Early models dealt only with the phenomenon of wastage (terminations). Assuming that wastage was related to length of service, for example, analysis could be made of the completed length of service distributions of a group of employees (i.e. a distribution of how long each employee had worked before terminating), and from the data a model could be built using some mathematical function to approximate the distribution. A variety of mathematical functions have been proposed, with varying degrees of success. [23] Most of the models are derived out of "cohort" analysis, that is, analysis of a large homogeneous group of employees, often numbering 1000 or greater. The lack of a large homogeneous population precluded the possibility of using one of this class of models for the Systems Group.

A second series of models were developed to simulate heterogeneous systems where employees are separated into group such as grade or age categories. These models incorporate concepts of both stocks and flows. The choice of a model in this series depends on the restraints on the systems to be modelled as well as on the assumptions made about the individuals within the system. Two distinct kinds of models emerge from the background assumptions. The first

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[23] David J. Bartholomew and Andrew F. Forbes, Statistical Techniques for Manpower Planning, (Chichester, England: John Wiley and Sons, Ltd., 1979), pp. 47-55.

set of models, Markov models, are based on the assumption that there is no restriction on the numbers of levels and positions that may be filled, and that movements will occur regardless of the numbers present at a level at any one time. Such a flow is considered to be a "push flow". [24] A second class of models, renewal models, is based on the assumptions that available positions are fixed in number, and that movements occur only as vacancies occur. These models are based on "pull flows". Bartholomew and Forbes compare the flows as follows:

> "Flows can...be classified according to whether the impetus for a move lies at its starting point or at its destination. Thus if an individual moves into a higher grade *because* it was necessary to fill a vacancy arising at that level we can think of the person as being pulled into the higher grade. If, on the other hand, the move to the higher grade is automatic as a result of acquiring a new qualification the move takes place because of an even occurring at the point of origin. Such flows are called *push* flows.
>
> This distinction between push and pull flows is often not as clear-cut as this account might suggest. There can, for example, be both a push and a pull element involved in a move as when a vacancy arises which can only be filled by a suitably qualified person....
>
> Wastage will always be treated as a push flow on the ground that its statistical characteristics can be adequately described in terms of factors concerning the present state of an individual like sex and length of service...Promotion, transfer, and recruitment can be treated in either way according to the type of system being modelled." [25]

Two factors make Markov models more appropriate for the Systems Group than renewal models, in terms of the theoretical basis. The first consideration is the growth

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[24] A. R. Smith, Manpower Planning in the Civil Service, (London: Her Majesty's Stationery Service, 1976), p. 79.
[25] Ibid., p. 8.

attempted by the Systems Group during the period of the study, which has diminished the limitations on the numbers of positions available. The continuing presence of vacant positions mean that movements are not restricted. The second factor is the Systems Group use of the growth-series classification structure. Promotions occur when the individuals are ready to be promoted rather than when a position becomes available. Only Systems Analyst IV positions are filled on the basis of vacancies rather than attainment of qualifications. Since they have constituted only a minority of positions through much of the study, the use of a Markov model would be more suitable.

A third class of models consist of individual simulation models where the behaviour of each member of the system is simulated using random numbers. A disadvantage cited is that it is difficult to gain the degree of insight into a complex system which a simpler mathematical model affords. [26] Due to the exploratory nature of this study, a simple system would be a more effective starting point to gain overall perspective.

Markov chain models assume that each person in the system has a given probability of making any particular move, that individuals move independently, and with identical probabilities that do not vary over time. [27] There are three kinds of movements that may be made: a person may stay where

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[26] Ibid., pp. 10-11.
[27] Ibid., pp. 86-87.

they are (sometimes called a transfer when viewed in connection with this kind of model), they may move to another grade (promotion or demotion), or they may leave the system entirely (termination or wastage). The probabilities of movements can be determined empirically through analysis of historical data, or they may be hypothesized.

Markov models start with current numbers of employees present in each category, and then proceed through an iterative process where for each period movements are first calculated and then recruitment into the system is added. When recruitment and movement parameters remain fixed, expected values of results would eventually converge to limiting values on the system. The systems may be modelled almost for an indefinite period of time.

A disadvantage of the model is that feedback effects cannot be incorporated, and so forecasts would be increasingly unreliable as the length of time modelled increased.

Several versions of a Markov simulation model were developed, using different measures of internal movements. Each model required the following inputs:

1. The beginning day of the six-month period providing the basis for the simulation.
2. The number of six-month intervals to be forecasted.
3. The numbers of employees on strength, by classification, at the beginning of the period.
4. The numbers of employees, by classification, recruited

during the six-month period. The numbers could be actual recruitment figures, or other figures (for example, planned numbers to be recruited).

5. The numbers of employees, by classification, terminated during the six-month period. (The numbers could be actual or expected numbers.)

Models differed only in terms of the data used to depict internal movements (promotions and demotions). The first model used actual or expected data from the six-month period that was acting as the starting point for the simulation. Using the actual data, the model calculated movement percentages which were then used for the forecasting calculations. A second model used historical average movement percentages derived from the entire five and one-half year period of the study. The percentages were applied to stock data to provide approximate numbers of employees moving internally, as well as to the forecasting calculations. A third model used average movement data derived from the last year of the five and one-half year period of the study. Appendix E contains sample simulation output.

The three kinds of inputs differ in terms of the underlying assumptions about the nature of the processes affecting the manpower pool. The first model, using only the most recent six months of data, assumes that the manpower pool is undergoing changes that may only be reflected accurately by current data. The model using five and

one-half year averages is based on the assumption that the manpower pool is stable and relatively unchanging in how movements occur; thus, data from a longer period will be more accurate since it provides a broader base to help flatten small variations from period to period. The third model, using data from a one-year period, is based on the assumption that seasonal variations exist that are yearly in nature. The third assumption is likely the most accurate. Recruitment showed variations from summer to winter. The manpower pool did not show enough consistency in attributes over the total period of the study to substantiate the assumption of stability for the entire period. A model using one year of data should therefore have a greater likelihood of predicting movements accurately.

The models were tested for goodness of fit using predictions based on 1976 and 1977 data against actual data in subsequent periods. The Markov models work with matrix calculations but they can be restated in such a manner that they can be treated as a standard multiple regression. Accordingly, the statistical tests used for goodness of fit were those for a multiple regression formula with six degrees of freedom (representing one outside point of entry into the system and five levels of positions within the system). Multiple correlation coefficients were measured for predictions for each grade of employee as well as total employees. See Table 20 for a summary of results.

TABLE 20

CLOSENESS OF FIT OF MODELS

DATA	PERIOD	PROG	SAI	SAII	SAIII	SAIV	TOTAL
AVERAGE MOVEMENT DATA AVERAGE RECRUITMENT DATA FOR THE YEAR	APR1976	.31	.04	.51	.44	.28	.41
	APR1977	.18	.15	.14	.15	.30	.17
AVERAGE MOVEMENT DATA FOR THE ENTIRE STUDY PERIOD-SPECIFIC RECRUITMENT DATA	APR1976	.08	.11	.58	.46	.03	.41
	OCT1976	.28	.28	.34	.23	.45	.11
	APR1977	.15	.11	.06	.13	.14	.17
PERIOD-SPECIFIC MOVEMENT AND RECRUITMENT DATA	APR1976	.06	.31	.74	.38	.32	.44
	OCT1976	.04	.25	.16	.25	.21	.17
	APR1977	.02	.09	.15	.08	.23	.16

None of the models were consistently successful in predictions for all grades at once. Models using yearly average data for recruitment might have been expected to be stronger because this would dampen seasonal variations in recruitment, but this was not borne out by the two trials. Models using average or period specific movement data both had varying degrees of success in prediction. The relatively small numbers of employees present in some grades may partly account for this since a slight variation in movement rates would have a big impact over time. Overall, the Systems Group tends to be small, and therefore is correspondingly difficult to model accurately.

The models may merely need more historical data than that from a five and one-half year period to help accurately allocate movement probabilities. One may also speculate that changes occurring outside the system, such as changes in the labour markets, have an impact on the system.

Despite the limited predictive success of the model, it may still serve a useful purpose in helping management evaluate long-range effects of present decision. A change in recruitment policies for a specific grade, for example, may be evaluated by inserting new recruitment figures into the input data. As mentioned previously, over an extended number of iterations, expected values would eventually converge to limiting values, and the long-range impact of the change could be assessed.

The models only used numbers of employees in specific positions as the basis of prediction for movements. The assumption is that any employee at a specific level has a certain probability of moving from that position during a period. Each employee at that level has an equal probability of moving. To simulate the movements the model uses a matrix representing the movements based on this single attribute. Were sufficient data available, models could be developed using matrices incorporating more characterisitics. For example, movements could be predicted on the basis of age and length of service in the organization as well as presence at a specific level. More complex models might be more difficult to manipulate, but they would have a greater chance to predict movements accurately due to the tacit incorporation of factors directly relating to an employee's likelihood to move from a position.

6. CONCLUSIONS AND RECOMMENDATIONS

A limitation arises out of the use of numerical techniques as the primary means of analyzing a population. This limitation is best described by A. R. Smith:

> "Any analysis of the trend of numbers over time implies that an association between time and numbers is suspected. In general it is merely descriptive and has little or no explanatory power in the sense of indicating the underlying reasons why numbers have changed the way they did.[28]

A statistical approach can be a necessary but not sufficient means of analyzing manpower systems. The lack of large numbers in the Systems Group increases the problem since the lack prevents accurate modelling with the current limited data available. A limited understanding of the underlying processes may prevent interested parties from interpreting results correctly, as well. To some extent, management must first work back to determine what areas it wishes to control, and what kinds of information it needs to fully assess the processes occurring in those areas. In general terms, the Systems Group has already established a general framework of manpower policy, based on broad departmental goals.

Alberta Government Services issued a series of five management priorities for 1981-82 in its annual statement of

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[28] A. R. Smith, Manpower Planning in the Civil Service. (london: Her Majesty's Stationery Service, 1976), p. 39.

goals. The second priority listed for the department was to "ensure that the department's current and future manpower requirements are met through the best combination of employee development and recruitment from internal and external sources, in a way that will allow the Department to continue to meet its established goals and objectives". The Systems Group has used these priorities as the basis for a set of two-year objectives which focus on staff development and manpower planning, planning and organization, and two other areas. There are goals to establish a manpower plan, develop and implement recruiting strategies, review and establish career plans, review key personnel issues, and to establish a training and career plan for all professional staff. [29] This does not represent a radical change in the department's or the Systems Group's goals, since elements of these objectives have appeared in statements issued in previous years. However, there is a trend to increased emphasis on human resource planning as a primary rather than secondary goal.

In order to develop effective policies in human resource management, one concept that may be used is that of control points. There are three basic sets of control points where management may influence personnel: points of entry into the system, points within the system, and points of exit from the system. Departmental goals emphasize concerns

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[29] Alberta Government Services, Information Services Division, Computer Systems Group, "1981/82 Goals", May, 1981.

over the first two areas, but neglect the third. Yet, analysis of the Systems Group manpower pool shows that a better understanding may be gained if all points are considered. For example, recruitment programs may be better evaluated if some consideration is given to retention patterns of employees from specific sources as well as total numbers recruited.

Concerns have been expressed in the Systems Group over its inability to grow fast enough to keep pace with the data processing industry, and over the loss of experienced personnel. Regrettably, this study provides little direct information leading to how they may solve these problems, but the data does have the potential of providing a focus for some areas of future consideration.

The task of gathering data for this study was complex and time-consuming because of the lack of integrated information in departmental records. The costs to the organization of gathering this information on an ongoing basis would be high compared to the potential value of the information gained. A more restricted selection of information would probably serve the needs of the organization better. The first decisions that management must make is what areas they wish to control, which have implications on that data that must be gathered. A decision to continue to emphasize recruitment will require information on recruitment sources and qualifications of personnel entering the system. A decision to control terminations more closely

might suggest collection of length of service data.

It is recommended that the Systems Group emphasize the importance of a perspective that allows for control of terminations as well as recruitment and employee development. Information that would be most useful in analyzing terminations would not come from departmental records, however, but from a program of exit interviews that determines more carefully why a perosn was leaving. Length of service, recruitment source, education, and other related data can still be gathered from secondary sources but there needs to be more direct research into why employees terminate.

The efficacy of recruitment programs could be better judged by the inclusion of some retention criteria in the definition of success. Although this information could be derived from current records, it might be more easily gathered through exit interviews.

The simulation models developed for the Systems Group require relatively simple data that can be gathered easily. Counts of recruitments, promotions, terminations and manpower stocks every six months would require relatively little clerical labour, and the possession of the data would ensure that the models could be used for policy evaluation at the least. Over time, the additional data may help to give a more reliable basis to calculations so that the models are better in their predictive ability. Although the models are capable of simulating a manpower system for up to

fifty years (100 intervals of six months each), it is recommended that the simulations be kept to a shorter period (eg. 3 years) for predictive purposes, and perhps five to ten years for the purposes of policy evaluation.

As the amount of data available increases, models should ideally be expanded to incorporate more factors such as length of service or salary level. More meaningful and specific personnel policies could be developed if there was a greater understanding of how specific factors such as these were related to personnel movements. It is hoped that an ongoing collection of information would eventually lead to a sufficient bank of data to more accurately pinpoint significant factors.

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APPENDIX A. SOURCE DOCUMENTS

Following is a list of the majority of forms that may be found on a personnel file of an individual employee. All forms use the employee name as a key reference. Although each form holds a variety of pieces of information, only the information that potentially could be used in the study is mentioned.

6.0.0.1 Recruitment Forms

PA01--APPLICATION FOR EMPLOYMENT: Name, date of birth, education, source (how became informed of competition, competition number).

PA054--OFFICIAL OATH

LETTER OF OFFER: Effective date of commencement, position type, branch.

RESUMES: Date of birth, marital status, education.

RETURN SERVICE AGREEMENT: Provision of assistance in relocation.

6.0.0.2 Salary and Position Administration Forms

AGS1210--NOTICE OF TERMINATION OF SALARIED EMPLOYEE: Reason for termination (categorized into resignation, dismissal, retirement, death), additional comments.

AGS1223--REQUEST FOR INCREMENT DECISION AND/OR RATING FORM

AFIS102--PAYROLL POSITION CONTROL: Budget information (Branch), position number.

AFIS111--PAYROLL EMPLOYEE STATUS RECORD: Position number, date of birth, appointment information, leave of absence information, employee salary control information.

AFIS112--PAYROLL EMPLOYEE STATUS UPDATE: Appointment information, personal status.

AFIS120--PAYROLL EXCEPTION PAYMENT

AFIS123--TERMINATION OF SUPPLEMENTARY PAYMENT: Position number, date of termination.

AFIS1000--PAYROLL REGISTER (SUPPLEMENTARY): Termination date.

AFIS1020--NOTICE OF ANNUAL SALARY: Name, position number, grade, and period.

DPC--NOTICE OF TRANSFER: Old position and class number, new position and class number, type of change (categorized into promotion, demotion, and transfer), effective date of change. (Form is no longer in use.)

DPC103--NOTICE OF COMMENCEMENT OF EMPLOYMENT: Date of birth, grade, dependents, sex, marital status.

DPC104--NOTICE OF CHANGE OF EMPLOYMENT OR SALARY RATE: Change due to reclassification, transfer, promotion, performance, and long service (service over six years at top salary level for that classification).

DPC114--NOTICE OF EMPLOYEE DEDUCTION

DPC131A--NOTICE OF VACATION ADVANCES

DPC624--POSITION ESTABLISHMENT STATUS

PA033--EMPLOYEE'S RECORD: Birthdate, marital status

(categorized into single, married, widow(er)), sex, class number, position number, grade and period, effective date, remarks.

PA089--POSITION CLASSIFICATION NOTICE: Class number, grade and period, title, position number.

TD1--EMPLOYEE'S TAX DEDUCTION RETURN: Name, date of birth, name and address of spouse, number and names of dependents.

6.0.0.3 Benefit Administration Forms

AHC110--GROUP NOTICE OF CHANGE: Addition of spouse.

AHC199--NOTICE OF EMPLOYEE GROUP COMMENCEMENT AND TERMINATION

ALBERTA PENSION ADMINISTRATION PF2--DESIGNATION OF BENEFICIARY

FORM 14--BLUE CROSS: Change of dependents.

FORM 230--BLUE CROSS TERMINATION NOTICE

DPC115--NOTICE OF ASSIGNMENT

DPC127--NOTICE OF CANCELLATION OF ASSIGNMENT

GREAT WEST LIFE M58A: Change of name of insured, change of name of insured's present beneficiary.

GROUP LIFE INSURANCE--OPTION FORM: Date of birth.

GROUP LIFE INSURANCE M+E/GL1-4: Termination, date of birth.

GROUP INSURANCE APPLICATION CARD M531: Beneficiary and relationship.

6.0.0.4 Miscellaneous Documents

AGS1231--REQUEST FOR ACTING INCUMBENT PAY

DPC106--NOTICE OF CHANGE OF PERSONAL STATUS: Change of birth date, change of employee number, change of marital status.

DPC108A--NOTICE OF ABSENCE

DPC129--PAYROLL TRUST ACCOUNTS NOTICE OF REFUNDS

PA05--EMPLOYEE PERFORMANCE RATING FORM

PA010--ATTENDANCE RECORD

PA0702--PERFORMANCE APPRAISAL

MEMOS: Memo of resignation, requests for leave of absence, and so on.

APPENDIX B. PROGRAM LISTING AND FLOWCHARTS

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C     THIS PROGRAM SIMULATES MANPOWER TURNOVER
C
C     INITIALIZE WORK AREAS
      REAL RECR,TERM,STOCK
      REAL MOVE
      REAL INMOV
      REAL TRECR,TTERM,TSTOCK
      REAL PMOVE,CALCNO,YEARS
      REAL OPERC
      YEARS=OO.O
      TRECR=O.O
      TTERM=O.O
      TSTOCK=O.O
      INTEGER OINTEG
      INTEGER DAY,YEAR
C
C     VARIABLES USED EXCLUSIVELY FOR SUBSCRIPTING
C     S=SOURCE,D=DESTINATION,T=TIME
C     G=GRADE
      INTEGER S,D,T
      INTEGER G
      INTEGER TIME
C
C     VECTORS TO HOLD INPUT DATA
C     VECTOR SHOWING THE ACTUAL NUMBERS RECRUITED INTO EACH CLASSIFICATION
C     DURING THE PRESENT INTERVAL
      DIMENSION RECR(5)
      DATA RECR/5*O.O/
C     VECTOR SHOWING NUMBERS TERMINATED FROM EACH CLASSIFICATION
C     DURING PRESENT INTERVAL
      DIMENSION TERM(5)
      DATA TERM/5*O.O/
C     VECTOR SHOWING NUMBERS PRESENT IN EACH CLASSIFICATION AT BEGINNING
C     OF PRESENT INTERVAL
      DIMENSION STOCK(5)
      DATA STOCK/5*O.O/
C     VECTORS SHOWING NUMBERS OF INTERNAL MOVEMENTS (PROMOTIONS,
C     DEMOTIONS,ETC) DURING PRESENT PERIOD
      DIMENSION INMOV(5)
      DATA INMOV/5*O.O/
C     TABLE TO CONSOLIDATE MOVE DATA
      DIMENSION MOVE(5,5)
      DATA MOVE/25*O.O/
C
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FINE PRINT

```
C     WORKING ARRAYS TO CONVERT INTEGER INPUT TO PERCENTAGES,
C     DO CALCULATIONS, AND HOLD OUTPUT FOR CALCULATION OF TOTALS
C
C     TABLE TO HOLD CALCULATED PERCENTAGES OF INTERNAL MOVEMENTS
      DIMENSION PMOVE(5,5)
      DATA PMOVE/25*0.0/
C     TABLE TO HOLD CALCULATED RESULTS FOR EACH INTERVAL
C     OF SIMULATION
      DIMENSION CALCNO(100,6)
      DATA CALCNO/600*0.0/
C     VECTOR TO HOLD OUTPUT IN INTEGER FORMAT
      DIMENSION OINTEG(6)
      DATA OINTEG/6*0/
C     VECTOR TO HOLD OUTPUT IN PERCENTAGE FORMAT
      DIMENSION OPERC(6)
      DATA OPERC/6*0.0/
C
C     FORMATS FOR ALL INPUT/OUTPUT LINES
C
3     FORMAT(I4,2(A4),I4)
4     FORMAT(I3)
5     FORMAT(F3.0,F3.0,F3.0,F3.0,F3.0)
8     FORMAT('1','MANPOWER DATA FOR THE SIX-MONTH PERIOD BEGINNING: ',
     1I4,2X,2(A4),2X,I4)
10    FORMAT('0',T34,'CLASSIFICATION')
11    FORMAT('0',T31,'SYSTEMS',T45,'SYSTEMS',T59,'SYSTEMS',
     1T72,'SYSTEMS',T89,'TOTAL')
12    FORMAT(' ',T16,'PROGRAMMER',T30,'ANALYST I',T44,
     1'ANALYST II',T57,'ANALYST III',T71,'ANALYST IV',
     2T87,'EMPLOYEES')
13    FORMAT(' ',T16,'NUMBER PERC',T29,'NUMBER PERC',T44,
     1'NUMBER PERC',T57,'NUMBER PERC',T70,'NUMBER PERC',
     2T85,'NUMBER PERC')
14    FORMAT('0','EMPLOYEES')
15    FORMAT(' ','CURRENTLY')
16    FORMAT('0','ON STRENGTH:',T16,I4,T30,I4,T44,I4,T57,
     1I4,T70,I4,T85,I4)
17    FORMAT('0','RECRUITMENT:',T16,I4,T30,I4,T44,I4,T57,
     1I4,T70,I4,T85,I4)
18    FORMAT('0','TERMINATIONS:',T16,I4,T30,I4,T44,I4,T57,
     1I4,T70,I4,T85,I4)
19    FORMAT('0',T16,'**************************************************
     1*****************************')
20    FORMAT('0',T31,'INTERNAL MOVEMENTS')
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FINE PRINT

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21    FORMAT('O',T35,'DESTINATIONS')
22    FORMAT(' ','S PROGRAMMER',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
23    FORMAT(' ','O ANALYST I',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
24    FORMAT(' ','U ANALYST II',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
25    FORMAT(' ','R ANALYST III',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
26    FORMAT(' ','C ANALYST IV',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
27    FORMAT(' ','E')
28    FORMAT('O','DURATION OF SIMULATION:',T28,I3,T33,
     1'SIX-MONTH INTERVALS',T57,'(= ',F3.1,T65,'YEARS)')
29    FORMAT('O','SIMULATION USES PERIOD-SPECIFIC MOVEMENT RATES')
30    FORMAT('1','FORECAST:',T23,
     1'REMAINING EMPLOYEES, BY CLASSIFICATION')
31    FORMAT('O','INTERVAL')
32    FORMAT(' ',T3,I3,T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')',T85,I4,' (',F6.2,')')
C
C     SET TIME TO EQUAL THE NUMBER OF 6-MONTH INTERVALS THAT
C     THE SIMULATION IS TO RUN (PRESENT INTERVAL WILL BE
C     CONSIDERED TO BE TIME=0)
      READ(5,4) TIME
      READ(5,3) DAY,P1,P2,YEAR
      WRITE(6,8) DAY,P1,P2,YEAR
C
C     CALCULATE TOTAL RECRUITMENT, TOTAL STOCKS, TOTAL TERMINATIONS
C     AND SET UP FOR OUTPUT
      WRITE(6,10)
      WRITE(6,11)
      WRITE(6,12)
      WRITE(6,13)
      WRITE(6,14)
      WRITE(6,15)
      READ(5,5) STOCK
100   DO 105 G=1,5
```

```
      TSTOCK = TSTOCK + STOCK (G)
      OINTEG (G) = STOCK (G)
105   CONTINUE
      OINTEG (6) = TSTOCK
      WRITE(6,16) OINTEG (1),OINTEG (2),OINTEG (3),OINTEG (4),
     1OINTEG (5), OINTEG (6)
      READ(5,5) RECR
110   DO 115 G=1,5
      TRECR = TRECR + RECR (G)
      OINTEG (G) = RECR (G)
115   CONTINUE
      OINTEG (6) = TRECR
      WRITE(6,17) OINTEG (1),OINTEG (2),OINTEG (3),OINTEG (4),
     1OINTEG (5), OINTEG (6)
      READ(5,5) TERM
120   DO 125 G=1,5
      TTERM = TTERM + TERM (G)
      OINTEG (G) = TERM (G)
125   CONTINUE
      OINTEG (6) = TTERM
      WRITE(6,18) OINTEG (1),OINTEG (2),OINTEG (3),OINTEG (4),
     1OINTEG (5), OINTEG (6)
C
C     CONSOLIDATE INPUT MOVE DATA INTO ONE TABLE
      READ(5,5) INMOV
130   DO 131 G=1,5
      MOVE (1,G) =INMOV (G)
131   CONTINUE
      READ(5,5) INMOV
132   DO 133 G=1,5
      MOVE (2,G) =INMOV (G)
133   CONTINUE
      READ(5,5) INMOV
134   DO 135 G=1,5
      MOVE (3,G) =INMOV (G)
135   CONTINUE
      READ(5,5) INMOV
136   DO 137 G=1,5
      MOVE (4,G) =INMOV (G)
137   CONTINUE
      READ(5,5) INMOV
138   DO 139 G=1,5
      MOVE (5,G) =INMOV (G)
139   CONTINUE
```

FINE PRINT

```
C
C     CALCULATE INTERNAL MOVEMENTS AS PERCENTAGES
C     S=SOURCE,D=DESTINATION
150   DO 165 S=1,5
152   DO 155 D=1,5
      PMOVE (S,D) = MOVE (S,D)
      PMOVE (S,D) = PMOVE (S,D) / STOCK (S)
      PMOVE (S,D) = PMOVE (S,D) * 100.0
155   CONTINUE
165   CONTINUE
      YEARS= TIME/2
      WRITE(6,19)
      WRITE(6,20)
      WRITE(6,21)
      WRITE(6,11)
      WRITE(6,12)
      WRITE(6,13)
170   DO 171 G=1,5
      OPERC (G)= PMOVE (1,G)
      OINTEG(G) = MOVE (1,G)
171   CONTINUE .
      WRITE(6,22) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
175   DO 176 G=1,5
      OPERC (G)= PMOVE (2,G)
      OINTEG(G) = MOVE (2,G)
176   CONTINUE
      WRITE(6,23) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
180   DO 181 G=1,5
      OPERC (G)= PMOVE (3,G)
      OINTEG(G) = MOVE (3,G)
181   CONTINUE
      WRITE(6,24) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
185   DO 186 G=1,5
      OPERC (G)= PMOVE (4,G)
      OINTEG(G) = MOVE (4,G)
186   CONTINUE
      WRITE(6,25) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
```

FINE PRINT

```
     2OINTEG (5),OPERC (5)
190   DO 191 G=1,5
      OPERC (G)= PMOVE (5,G)
      OINTEG(G) = MOVE (5,G)
191   CONTINUE
      WRITE(6,26) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
      WRITE(6,27)
      WRITE(6,19)
      WRITE(6,28) TIME,YEARS
      WRITE(6,29)
C
C
C     START FORECASTING
C
C     INITIALIZE TIME(O) WITH CURRENT STOCKS
200   DO 205 G=1,5
      CALCNO (1,G) =  STOCK (G)
      OINTEG (G) =  STOCK (G)
205   CONTINUE
      CALCNO (1,6) = TSTOCK
      OINTEG (6) = TSTOCK
250   DO 255 G=1,5
      OPERC (G)= 100*CALCNO (1,G)/CALCNO (1,6)
255   CONTINUE
      OPERC (6) =  100.0
      T=O
C     WRITE OUT TITLES AND INITIAL DETAIL LINE OF FORECAST
      WRITE(6,30)
      WRITE(6,11)
      WRITE(6,12)
      WRITE(6,13)
      WRITE(6,31)
      WRITE(6,32) T,OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),OINTEG (5),
     2OPERC (5),OINTEG (6),OPERC (6)
C
C     REINITIALIZE OUTPUT LINES
300   DO 305 G=1,6
      OINTEG (G) =  O
      OPERC (G) =  0.0
305   CONTINUE
C
```

FINE PRINT

```
C     DO SIMULATION FOR REQUIRED LENGTH OF TIME
1000  DO 5000 T=1,TIME
1100  DO 1900 D=1,5
1110  DO 1115 S=1,5
      CALCNO (T+1,D)= CALCNO (T+1,D) + CALCNO (T,S)*PMOVE (S,D)/100
1115  CONTINUE
      CALCNO (T+1,D)= CALCNO (T+1,D) + RECR (D)
1900  CONTINUE
C     CALCULATE TOTAL
2000  DO 2005 G=1,5
      CALCNO (T+1,6)=  CALCNO (T+1,6) + CALCNO (T+1,G)
2005  CONTINUE
C     CALCULATE INTEGER OUTPUT
3000  DO 3005 G=1,5
      OINTEG (G) =  CALCNO (T+1,G) + 0.5
3005  CONTINUE
      OINTEG (6) = CALCNO (T+1,6) + 0.5
C     CALCULATE PERCENTAGES
      OPERC (6)= 100*CALCNO (T+1,6)/CALCNO (T,6)
4000  DO 4005 G=1,5
      OPERC (G)= 100*CALCNO (T+1,G)/CALCNO (T+1,6)
4005  CONTINUE
C     WRITE OUT DETAIL LINE
      WRITE(6,32) T,OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),OINTEG (5),
     2OPERC (5),OINTEG (6),OPERC (6)
C
C     REINITIALIZE OUTPUT LINES
4500  DO 4505 G=1,6
      OINTEG (G) =  0000
      OPERC (G) =  000.0
4505  CONTINUE
5000  CONTINUE
      STOP
      END
```

FINE PRINT

```
C     THIS PROGRAM SIMULATES MANPOWER TURNOVER
C     USING STANDARD MOVEMENT PERCENTAGES
C
C     INITIALIZE WORK AREAS
      REAL RECR,TERM,STOCK
      REAL INMOV
      REAL TRECR,TTERM,TSTOCK
      REAL PMOVE,CALCNO,YEARS
      REAL OPERC
      TRECR=0.0
      TTERM=0.0
      TSTOCK=0.0
      INTEGER OINTEG
      INTEGER MOVE
      INTEGER DAY,YEAR
C     VARIABLES USED EXCLUSIVELY FOR SUBSCRIPTING
C     S=SOURCE,D=DESTINATION,T=TIME
C     G=GRADE
      INTEGER S,D,T
      INTEGER G
      INTEGER TIME
C
C     VECTORS TO HOLD INPUT DATA
C     VECTOR SHOWING THE ACTUAL NUMBERS RECRUITED INTO EACH CLASSIFICATION
C     DURING THE PRESENT INTERVAL
      DIMENSION RECR(5)
      DATA RECR/5*0.0/
C     VECTOR SHOWING NUMBERS TERMINATED FROM EACH CLASSIFICATION
C     DURING PRESENT INTERVAL
      DIMENSION TERM(5)
      DATA TERM/5*0.0/
C     VECTOR SHOWING NUMBERS PRESENT IN EACH CLASSIFICATION AT BEGINNING
C     OF PRESENT INTERVAL
      DIMENSION STOCK(5)
      DATA STOCK/5*0.0/
C     WORKING ARRAYS TO CONVERT INTEGER INPUT TO PERCENTAGES,
C     DO CALCULATIONS, AND HOLD OUTPUT FOR CALCULATION OF TOTALS
C
C     TABLE TO HOLD CALCULATED PERCENTAGES OF INTERNAL MOVEMENTS
      DIMENSION PMOVE(5,5)
      DATA PMOVE/51.0,0.0,0.0,0.0,0.0,0.0,41.0,49.0,0.0,0.0,0.0,0.0,1.0,38.0,52
     1.0,0.0,0.0,0.0,1.0,32.0,76.0,0.0,0.0,0.0,0.0,0.0,8.0,85.0/
C     TABLE TO HOLD CALCULATED RESULTS FOR EACH INTERVAL
C     OF SIMULATION
```

FINE PRINT

```
      DIMENSION CALCNO(100,6)
      DATA CALCNO/600*0.0/
C     VECTOR TO HOLD OUTPUT IN INTEGER FORMAT
      DIMENSION OINTEG(6)
      DATA OINTEG/6*0/
C     VECTOR TO HOLD OUTPUT IN PERCENTAGE FORMAT
      DIMENSION OPERC(6)
      DATA OPERC/6*0.0/
C
      YEARS=00.0
C     FORMATS FOR ALL INPUT/OUTPUT LINES
C
3     FORMAT(I4,2(A4),I4)
4     FORMAT(I3)
5     FORMAT(F3.0,F3.0,F3.0,F3.0,F3.0)
8     FORMAT('1','MANPOWER DATA FOR THE SIX-MONTH PERIOD BEGINNING: ',
     1I4,2X,2(A4),2X,I4)
10    FORMAT('0',T34,'CLASSIFICATION')
11    FORMAT('0',T31,'SYSTEMS',T45,'SYSTEMS',T59,'SYSTEMS',
     1T72,'SYSTEMS',T89,'TOTAL')
12    FORMAT(' ',T16,'PROGRAMMER',T30,'ANALYST I',T44,
     1'ANALYST II',T57,'ANALYST III',T71,'ANALYST IV',
     2T87,'EMPLOYEES')
13    FORMAT(' ',T16,'NUMBER PERC',T29,'NUMBER PERC',T44,
     1'NUMBER PERC',T57,'NUMBER PERC',T70,'NUMBER PERC',
     2T85,'NUMBER PERC')
14    FORMAT('0','EMPLOYEES')
15    FORMAT(' ','CURRENTLY')
16    FORMAT(' ','ON STRENGTH:',T16,I4,T30,I4,T44,I4,T57,
     1I4,T70,I4,T85,I4)
17    FORMAT(' ','RECRUITMENT:',T16,I4,T30,I4,T44,I4,T57,
     1I4,T70,I4,T85,I4)
18    FORMAT(' ','TERMINATIONS:',T16,I4,T30,I4,T44,I4,T57,
     1I4,T70,I4,T85,I4)
19    FORMAT('0',T20,'**************************************************
     1*************************')
20    FORMAT('0',T31,'INTERNAL MOVEMENTS')
21    FORMAT('0',T35,'DESTINATIONS')
22    FORMAT('0','S PROGRAMMER',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
23    FORMAT(' ','0 ANALYST I',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
```

```
24    FORMAT(' ','U ANALYST II',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
25    FORMAT(' ','R ANALYST III',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
26    FORMAT(' ','C ANALYST IV',T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')')
27    FORMAT(' ','E')
28    FORMAT('0','DURATION OF SIMULATION:',T28,I3,T33,
     1'SIX MONTH INTERVALS',T57,'(= ',F3.1,T65,'YEARS)')
29    FORMAT('0','SIMULATION USES AVERAGE MOVEMENT RATES')
30    FORMAT('1','FORECAST:',T23,
     1'REMAINING EMPLOYEES, BY CLASSIFICATION')
31    FORMAT('0','INTERVAL')
32    FORMAT(' ',T3,I3,T16,I4,' (',F6.2,')',T30,I4,' (',
     1F6.2,')',T44,I4,' (',F6.2,')',T57,I4,' (',F6.2,')',T70,I4,
     2' (',F6.2,')',T85,I4,' (',F6.2,')')
C
C     SET TIME TO EQUAL THE NUMBER OF 6-MONTH INTERVALS THAT
C     THE SIMULATION IS TO RUN (PRESENT INTERVAL WILL BE
C     CONSIDERED TO BE TIME=0)
      READ(5,4) TIME
C
C     CALCULATE TOTAL RECRUITMENT, TOTAL STOCKS, TOTAL TERMINATIONS
C     AND SET UP FOR OUTPUT
      READ(5,3) DAY,P1,P2,YEAR
      WRITE(6,8) DAY,P1,P2,YEAR
      WRITE(6,10)
      WRITE(6,11)
      WRITE(6,12)
      WRITE(6,13)
      WRITE(6,14)
      WRITE(6,15)
      READ(5,5) STOCK
100   DO 105 G=1,5
      TSTOCK = TSTOCK + STOCK (G)
      OINTEG (G) = STOCK (G)
105   CONTINUE
      OINTEG (6) = TSTOCK
      WRITE(6,16) OINTEG (1),OINTEG (2),OINTEG (3),OINTEG (4),
     1OINTEG (5), OINTEG (6)
      READ(5,5) RECR
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FINE PRINT

```
110   DO 115 G=1,5
      TRECR = TRECR + RECR (G)
      OINTEG (G) = RECR (G)
115   CONTINUE
      OINTEG (6) = TRECR
      WRITE(6,17) OINTEG (1),OINTEG (2),OINTEG (3),OINTEG (4),
     1OINTEG (5), OINTEG (6)
      READ(5,5) TERM
120   DO 125 G=1,5
      TTERM = TTERM + TERM (G)
      OINTEG (G) = TERM (G)
125   CONTINUE
      OINTEG (6) = TTERM
      WRITE(6,18) OINTEG (1),OINTEG (2),OINTEG (3),OINTEG (4),
     1OINTEG (5), OINTEG (6)
C
      YEARS= TIME/2
      WRITE(6,19)
      WRITE(6,20)
      WRITE(6,21)
      WRITE(6,11)
      WRITE(6,12)
      WRITE(6,13)
170   DO 171 G=1,5
      OPERC (G)= PMOVE (1,G)
      OINTEG(G) = PMOVE(1,G) * STOCK (1) /100.0 +0.5
171   CONTINUE
      WRITE(6,22) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
175   DO 176 G=1,5
      OPERC (G)= PMOVE (2,G)
      OINTEG(G) = PMOVE(2,G) * STOCK (2) /100.0 +0.5
176   CONTINUE
      WRITE(6,23) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
180   DO 181 G=1,5
      OPERC (G)= PMOVE (3,G)
      OINTEG(G) = PMOVE(3,G) * STOCK(3) /100.0 +0.5
181   CONTINUE
      WRITE(6,24) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
```

FINE PRINT

```
185   DO 186 G=1,5
      OPERC (G)= PMOVE (4,G)
      OINTEG(G) = PMOVE(4,G) * STOCK(4) /100.0 +0.5
186   CONTINUE
      WRITE(6,25) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
190   DO 191 G=1,5
      OPERC (G)= PMOVE (5,G)
      OINTEG(G) = PMOVE(5,G) * STOCK(5) /100.0 +0.5
191   CONTINUE
      WRITE(6,26) OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),
     2OINTEG (5),OPERC (5)
      WRITE(6,27)
      WRITE(6,28) TIME,YEARS
      WRITE(6,29)
C
C
C     START FORECASTING
C     INITIALIZE TIME(0) WITH CURRENT STOCKS
200   DO 205 G=1,5
      CALCNO (1,G) =  STOCK (G)
      OINTEG (G) =  STOCK (G)
205   CONTINUE
      CALCNO (1,6) = TSTOCK
      OINTEG (6) = TSTOCK
250   DO 255 G=1,5
      OPERC (G)= 100*CALCNO (1,G)/CALCNO (1,6)
255   CONTINUE
      OPERC (6) =  100.0
      T=0
C     WRITE OUT TITLES AND INITIAL DETAIL LINE OF FORECAST
      WRITE(6,30)
      WRITE(6,11)
      WRITE(6,12)
      WRITE(6,13)
      WRITE(6,31)
      WRITE(6,32) T,OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     1OINTEG (3),OPERC (3),OINTEG (4),OPERC (4),OINTEG (5),
     2OPERC (5),OINTEG (6),OPERC (6)
C
C     REINITIALIZE OUTPUT LINES
300   DO 305 G=1,6
```

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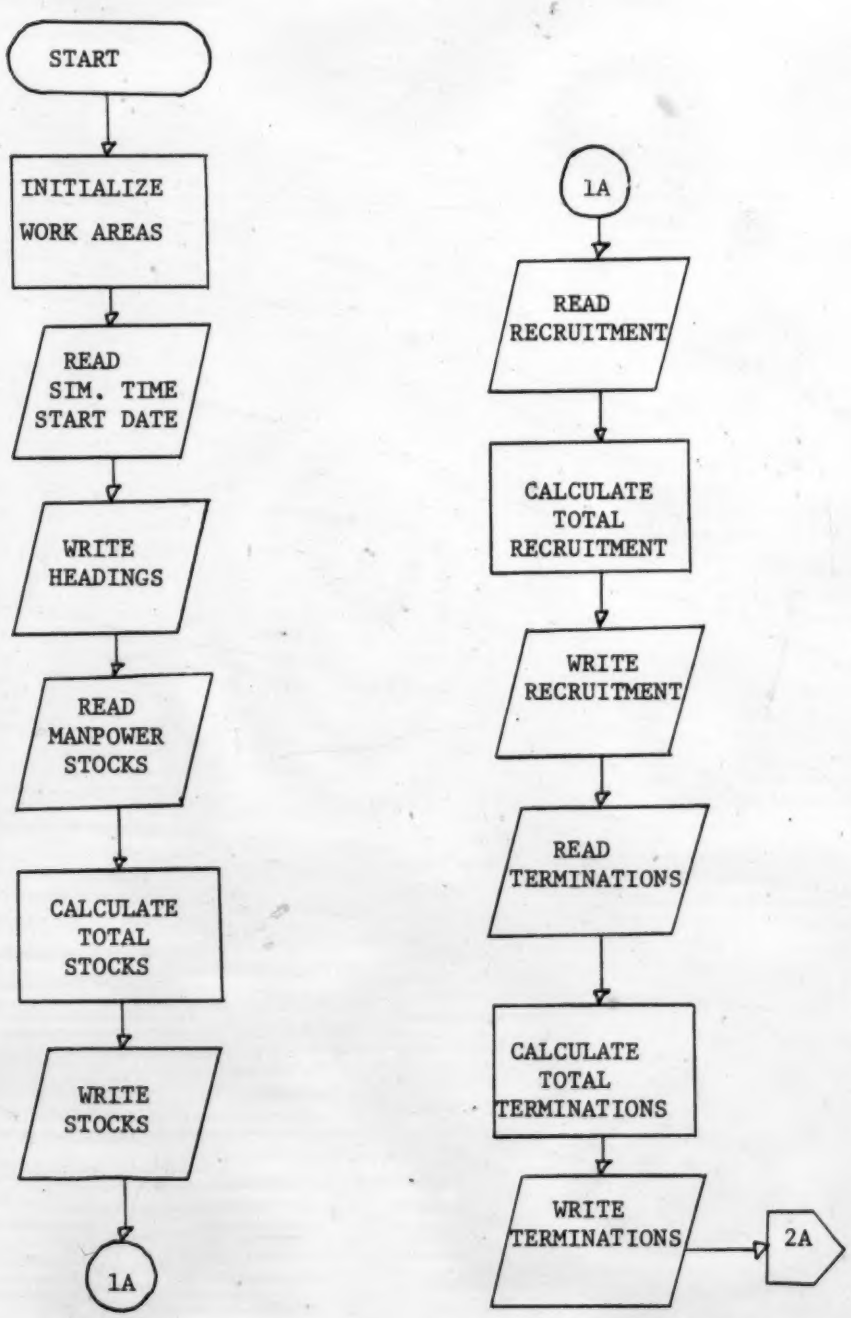
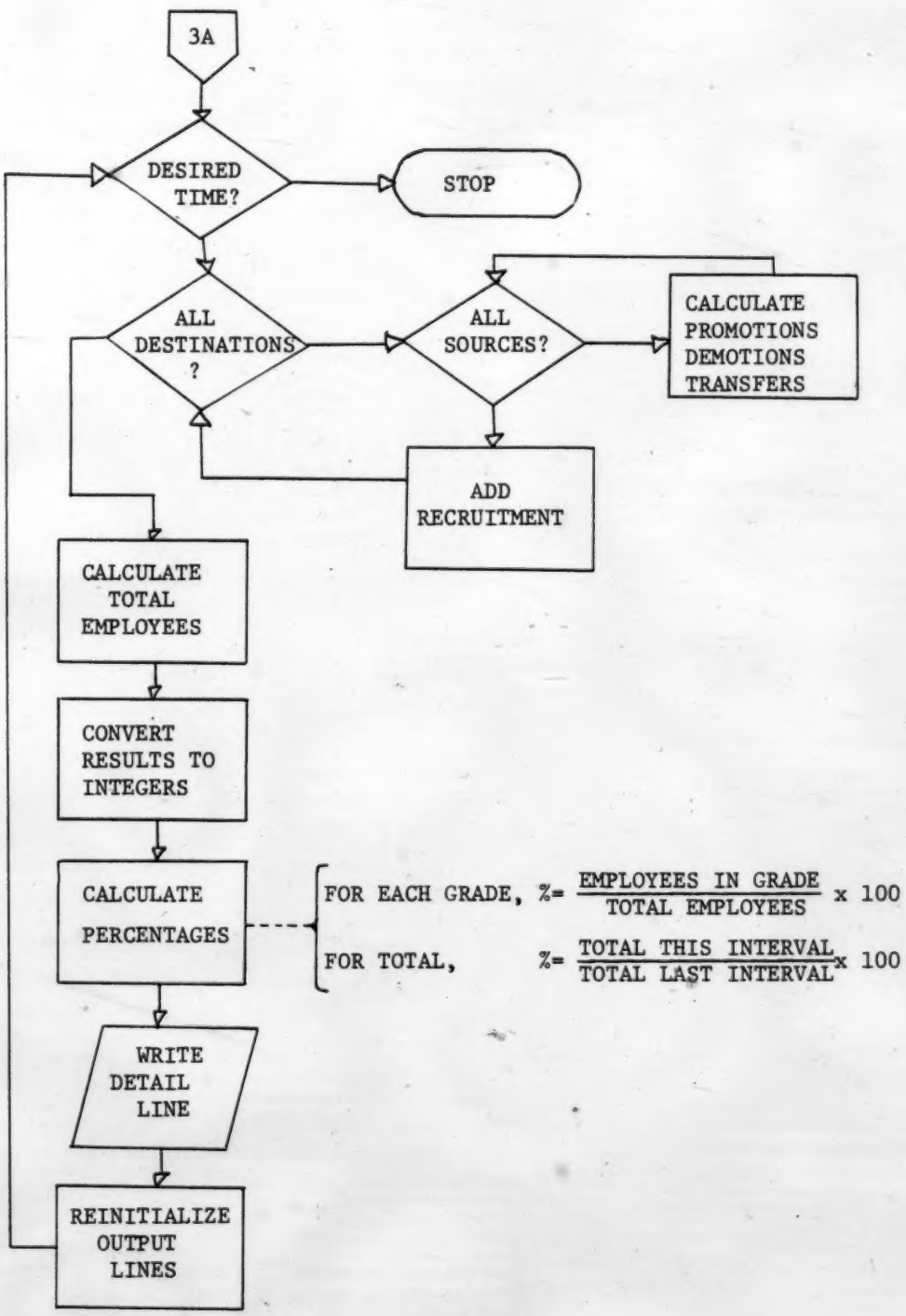
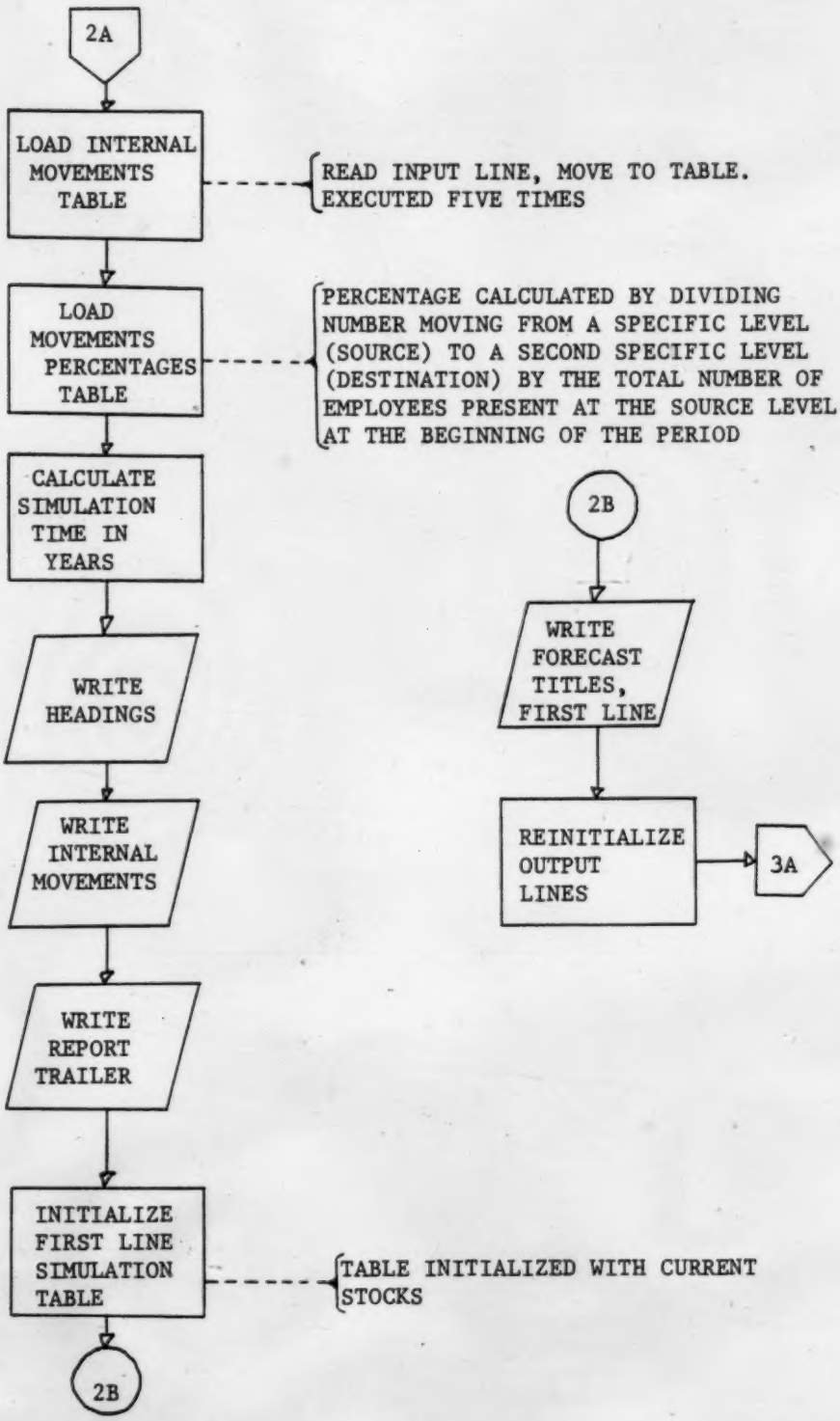
```
      OINTEG (G) =  0
      OPERC (G) =  0.0
305   CONTINUE
C     DO SIMULATION FOR REQUIRED LENGTH OF TIME
1000  DO 5000 T=1,TIME
1100  DO 1900 D=1,5
1110  DO 1115 S=1,5
      CALCNO (T+1,D)= CALCNO (T+1,D) + CALCNO (T,S)*PMOVE (S,D)/100
1115  CONTINUE
      CALCNO (T+1,D)= CALCNO (T+1,D) + RECR (D)
1900  CONTINUE
C     CALCULATE TOTAL
2000  DO 2005 G=1,5
      CALCNO (T+1,6)=  CALCNO (T+1,6) + CALCNO (T+1,G)
2005  CONTINUE
C     CALCULATE INTEGER OUTPUT
3000  DO 3005 G=1,5
      OINTEG (G) =  CALCNO (T+1,G) + 0.5
3005  CONTINUE
      OINTEG (6) = CALCNO (T+1,6) + 0.5
C     CALCULATE PERCENTAGES
      OPERC (6)= 100*CALCNO (T+1,6)/CALCNO (T,6)
4000  DO 4005 G=1,5
      OPERC (G)= 100*CALCNO (T+1,G)/CALCNO (T+1,6)
4005  CONTINUE
C     WRITE OUT DETAIL LINE
      WRITE(6,32) T,OINTEG (1),OPERC (1),OINTEG (2),OPERC (2),
     10INTEG (3),OPERC (3),OINTEG (4),OPERC (4),OINTEG (5),
     20PERC (5),OINTEG (6),OPERC (6)
C
C     REINITIALIZE OUTPUT LINES
4500  DO 4505 G=1,6
      OINTEG (G) =  0000
      OPERC (G) =  000.0
4505  CONTINUE
5000  CONTINUE
      STOP
      END
```

FINE PRINT


START
INITIALIZE WORK AREAS
READ SIM. TIME START DATE
WRITE HEADINGS
READ MANPOWER STOCKS
CALCULATE TOTAL STOCKS
WRITE STOCKS
1A
1A
READ RECRUITMENT
CALCULATE TOTAL RECRUITMENT
WRITE RECRUITMENT
READ TERMINATIONS
CALCULATE TOTAL TERMINATIONS
WRITE TERMINATIONS
2A


3A
DESIRED TIME?
STOP
ALL DESTINATIONS ?
ALL SOURCES?
CALCULATE PROMOTIONS DEMOTIONS TRANSFERS
ADD RECRUITMENT
CALCULATE TOTAL EMPLOYEES
CONVERT RESULTS TO INTEGERS
CALCULATE PERCENTAGES
FOR EACH GRADE, %= EMPLOYEES IN GRADE / TOTAL EMPLOYEES x 100
FOR TOTAL, %= TOTAL THIS INTERVAL / TOTAL LAST INTERVAL x 100
WRITE DETAIL LINE
REINITIALIZE OUTPUT LINES


2A
LOAD INTERNAL MOVEMENTS TABLE
READ INPUT LINE, MOVE TO TABLE. EXECUTED FIVE TIMES
LOAD MOVEMENTS PERCENTAGES TABLE
PERCENTAGE CALCULATED BY DIVIDING NUMBER MOVING FROM A SPECIFIC LEVEL (SOURCE) TO A SECOND SPECIFIC LEVEL (DESTINATION) BY THE TOTAL NUMBER OF EMPLOYEES PRESENT AT THE SOURCE LEVEL AT THE BEGINNING OF THE PERIOD
CALCULATE SIMULATION TIME IN YEARS
WRITE HEADINGS
WRITE INTERNAL MOVEMENTS
WRITE REPORT TRAILER
INITIALIZE FIRST LINE SIMULATION TABLE
TABLE INITIALIZED WITH CURRENT STOCKS
2B
2B
WRITE FORECAST TITLES, FIRST LINE
REINITIALIZE OUTPUT LINES
3A

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MULTIPLE-CARD LAYOUT FORM

Company: ALBERTA GOVERNMENT SERVICES

Application: MANPOWER SIMULATION (GENERAL) by: HELEN COX Date: MARCH 1982 Job No. Sheet No. 1

12/3/21

1. LENGTH OF SIMULATION (INTEGER)

DESCRIPTION: RIGHT-JUSTIFIED INTEGER FIELD INDICATING THE NUMBER OF SIX-MONTH PERIODS THE SIMULATION IS TO RUN.

2. DAY (INTEGER) -- MONTH -- (ALPHA-NUMERIC) YEAR (INTEGER)

DESCRIPTION: INTEGER FIELDS BOTH RIGHT-JUSTIFIED.
MONTH FIELD ACCEPTS ANY VALID FORTRAN CHARACTERS.

3. PROG SAI SAII SAIII SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FIELDS INDICATE THE NUMBERS OF EMPLOYEES ON STRENGTH, BY CLASSIFICATION.

4. PROG SAI SAII SAIII SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FIELDS INDICATE THE NUMBER OF EMPLOYEES RECRUITED INTO EACH CLASSIFICATION (DOES NOT INCLUDE PROMOTION).

5. PROG SAI SAII SAIII SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FIELDS INDICATE THE NUMBERS OF EMPLOYEES TERMINATED FROM EACH CLASSIFICATION.
(FOR SA IV'S, A PROMOTION TO SENIOR OFFICER POSITION IS CONSIDERED TO BE A TERMINATION.)

6. PROG-PROG PROG-SAI PROG-SAII PROG-SAIII PROG-SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FIELDS INDICATE THE INTERNAL MOVEMENTS OF PROGRAMMERS DURING PERIOD.

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DP/F/21

MULTIPLE-CARD LAYOUT FORM

Company: ALBERTA GOVERNMENT SERVICES

Application: MANPOWER SIMULATION (GENERAL) by: HELEN COX Date: MARCH 1982 Job No.: 1 Sheet No.: 2

7. SAI-PROG | SAI-SAI | SAI-SAII | SAI-SAIII | SAI-SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FIELDS INDICATE THE INTERNAL MOVEMENTS OF SYSTEMS ANALYST I'S DURING PERIOD.

8. SAII-PROG | SAII-SAI | SAII-SAII | SAII-SAIII | SAII-SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FILEDS INDICATE THE INTERNAL MOVEMENTS OF SYSTEMS ANALYST II'S DURING PERIOD.

9. SAIII-PROG | SAIII-SAI | SAIII-SAII | SAIII-SAIII | SAIII-SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FIELDS INDICATE THE INTERNAL MOVEMENTS OF SYSTEMS ANALYST III'S DURING PERIOD.

10. SAIV-PROG | SAIV-SAI | SAIV-SAII | SAIV-SAIII | SAIV-SAIV

DESCRIPTIONS: ALL FIELDS RIGHT-JUSTIFIED INTEGER FIELDS.
FIELDS INDICATE THE INTERNAL MOVEMENTS OF SYSTEM ANALYST IV'S DURING PERIOD.

FILE MUST BE CONSTRUCTED IN THE ORDER GIVEN IN THE LEFT-HAND MARGIN.
SIMULATIONS USING PERIOD-SPECIFIC MOVEMENT DATA REQUIRE ALL TEN LINES OF INPUT.
SIMULATIONS USING AVERAGE MOVEMENT DATA REQUIRE ONLY THE FIRST FIVE LINES OF INPUT.

NOTE: ALL INTEGER FIELDS SHOULD CONTAIN DATA. USE ZEROES TO INDICATE NO ACTIVITY.

APPENDIX C. SAMPLE SIMULATION OUTPUT

The first page of the simulation output summarizes the data used as the basis of the simulation. The first table depicts the employees on strength *at the beginning of the period*, and the recruitment and terminations that have occurred *during* the six-month period. Total numbers for each line are calculated by the program. The second table summarizes the internal movements that occurred *during* the period. The table is read from left to right. For example, the first row indicates the movements of any programmers during the period. Those having the destination of "Programmer" have continued at their present level. Those having the destination of "Systems Analyst I" have been promoted during the interval, and so on. The percentages shown in brackets are calculated by dividing the numbers of programmers arriving at a particular destination by the total number of programmers present at the beginning of the interval. Rounding errors may prevent the percentages from adding up to 100.00.

The first model derives percentages from the actual numbers of personnel that have moved during the period. The other models use average percentages and actual stocks of personnel to calculate approximate numbers of internal movements. Rounding problems caused by the conversion of

calculated real numbers to integer format result in less accuracy of the numbers of personnel moved; the numbers are provided only as a guide to aid in the comprehension of the movement percentages.

The first page of the simulation output ends with a line describing the forecast period of the simulation and a description of the movement rates used in the calculations

The second page of the simulation output depicts the forecasted results for future time periods. Interval "0" represents the current period that has acted as the basis for the simulation calculations. The integer numbers for each classification stand for the numbers of employees at that classification at the beginning of the interval. The percentages in brackets incicate the proportion of the employees at that classification relative to the total number of employees present at the beginning of the period.

Each subsequent line of the forecast indicates the numbers of employees expected to be present at each level at the beginning of the period. Again, the percentages beside each number indicate the proportion of employees at each level relative to the total numbers of employees forecast for that period. The percentage figure beside the total number of employees forecast is derived from comparing the total number present at each interval to those of the

interval directly preceeding it.

MANPOWER DATA FOR THE SIX-MONTH PERIOD BEGINNING: 1 APRIL 1981

CLASSIFICATION

	PROGRAMMER NUMBER	PERC	SYSTEMS ANALYST I NUMBER	PERC	SYSTEMS ANALYST II NUMBER	PERC	SYSTEMS ANALYST III NUMBER	PERC	SYSTEMS ANALYST IV NUMBER	PERC	TOTAL EMPLOYEES NUMBER	PERC
EMPLOYEES CURRENTLY ON STRENGTH:	10		18		11		24		19		82	
RECRUITMENT:	13		10		1		2		0		26	
TERMINATIONS:	1		3		1		5		5		15	

****

INTERNAL MOVEMENTS

DESTINATIONS

	PROGRAMMER NUMBER	PERC	SYSTEMS ANALYST I NUMBER	PERC	SYSTEMS ANALYST II NUMBER	PERC	SYSTEMS ANALYST III NUMBER	PERC	SYSTEMS ANALYST IV NUMBER	PERC	TOTAL EMPLOYEES NUMBER	PERC
S PROGRAMMER	4	(40.00)	5	(50.00)	0	(0.0)	0	(0.0)	0	(0.0)		
O ANALYST I	0	(0.0)	8	(44.44)	7	(38.89)	0	(0.0)	0	(0.0)		
U ANALYST II	0	(0.0)	0	(0.0)	9	(81.82)	1	(9.09)	0	(0.0)		
R ANALYST III	0	(0.0)	0	(0.0)	0	(0.0)	17	(70.83)	2	(8.33)		
C ANALYST IV	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	14	(73.68)		
E												

DURATION OF SIMULATION: 10 SIX-MONTH INTERVALS (= 5.0 YEARS)

SIMULATION USES PERIOD-SPECIFIC MOVEMENT RATES

FORECAST: REMAINING EMPLOYEES, BY CLASSIFICATION

INTERVAL	PROGRAMMER NUMBER	PERC	SYSTEMS ANALYST I NUMBER	PERC	SYSTEMS ANALYST II NUMBER	PERC	SYSTEMS ANALYST III NUMBER	PERC	SYSTEMS ANALYST IV NUMBER	PERC	TOTAL EMPLOYEES NUMBER	PERC
0	10	(12.20)	18	(21.95)	11	(13.41)	24	(29.27)	19	(23.17)	82	(100.00)
1	17	(18.28)	23	(24.73)	17	(18.28)	20	(21.51)	16	(17.20)	93	(113.41)
2	20	(19.12)	29	(27.74)	24	(23.04)	18	(17.11)	13	(13.00)	104	(111.34)
3	21	(18.45)	33	(28.81)	32	(27.95)	17	(14.74)	11	(10.05)	113	(109.50)
4	21	(17.45)	35	(28.56)	40	(32.35)	17	(13.65)	10	(7.99)	122	(108.03)
5	22	(16.47)	36	(27.69)	47	(35.94)	17	(13.33)	9	(6.58)	131	(106.84)
6	22	(15.61)	37	(26.63)	54	(38.68)	19	(13.45)	8	(5.63)	138	(105.83)
7	22	(14.89)	37	(25.59)	59	(40.70)	20	(13.80)	7	(5.02)	145	(104.98)
8	22	(14.29)	37	(24.65)	64	(42.15)	22	(14.25)	7	(4.65)	152	(104.23)
9	22	(13.80)	37	(23.85)	68	(43.18)	23	(14.72)	7	(4.45)	157	(103.60)
10	22	(13.39)	37	(23.16)	71	(43.91)	25	(15.16)	7	(4.38)	162	(103.04)

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MANPOWER DATA FOR THE SIX-MONTH PERIOD BEGINNING: 1 APRIL 1981

CLASSIFICATION

	PROGRAMMER NUMBER	PERC	SYSTEMS ANALYST I NUMBER	PERC	SYSTEMS ANALYST II NUMBER	PERC	SYSTEMS ANALYST III NUMBER	PERC	SYSTEMS ANALYST IV NUMBER	PERC	TOTAL EMPLOYEES NUMBER	PERC
EMPLOYEES CURRENTLY ON STRENGTH:	10		18		11		24		19		82	
RECRUITMENT:	13		10		1		2		0		26	
TERMINATIONS:	1		3		1		5		5		15	

****

INTERNAL MOVEMENTS

DESTINATIONS

	PROGRAMMER NUMBER	PERC	SYSTEMS ANALYST I NUMBER	PERC	SYSTEMS ANALYST II NUMBER	PERC	SYSTEMS ANALYST III NUMBER	PERC	SYSTEMS ANALYST IV NUMBER	PERC	TOTAL EMPLOYEES NUMBER	PERC
S PROGRAMMER	5	(51.00)	4	(41.00)	0	(1.00)	0	(0.0)	0	(0.0)		
O ANALYST I	0	(0.0)	9	(49.00)	7	(38.00)	0	(1.00)	0	(0.0)		
U ANALYST II	0	(0.0)	0	(0.0)	6	(52.00)	4	(32.00)	0	(0.0)		
R ANALYST III	0	(0.0)	0	(0.0)	0	(0.0)	18	(76.00)	2	(8.00)		
C ANALYST IV	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	16	(85.00)		
E												

DURATION OF SIMULATION: 10 SIX MONTH INTERVALS (= 5.0 YEARS)

SIMULATION USES AVERAGE MOVEMENT RATES

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FORECAST: REMAINING EMPLOYEES, BY CLASSIFICATION

INTERVAL	PROGRAMMER NUMBER	PERC	SYSTEMS ANALYST I NUMBER	PERC	SYSTEMS ANALYST II NUMBER	PERC	SYSTEMS ANALYST III NUMBER	PERC	SYSTEMS ANALYST IV NUMBER	PERC	TOTAL EMPLOYEES NUMBER	PERC
0	10	(12.20)	18	(21.95)	11	(13.41)	24	(29.27)	19	(23.17)	82	(100.00)
1	18	(18.72)	23	(23.70)	14	(14.13)	24	(24.76)	18	(18.69)	97	(117.91)
2	22	(20.22)	29	(26.06)	17	(15.46)	25	(22.55)	17	(15.71)	110	(113.71)
3	24	(20.00)	33	(27.25)	21	(17.22)	27	(21.84)	17	(13.70)	122	(110.67)
4	25	(19.27)	36	(27.47)	25	(18.75)	29	(22.16)	16	(12.35)	132	(108.40)
5	26	(18.45)	38	(27.13)	28	(19.82)	32	(23.09)	16	(11.51)	141	(106.67)
6	26	(17.71)	39	(26.55)	30	(20.42)	36	(24.29)	16	(11.04)	148	(105.34)
7	26	(17.07)	40	(25.90)	32	(20.67)	39	(25.51)	17	(10.86)	155	(104.31)
8	26	(16.53)	40	(25.27)	33	(20.68)	43	(26.62)	17	(10.89)	160	(103.50)
9	26	(16.10)	41	(24.71)	34	(20.56)	45	(27.57)	18	(11.07)	165	(102.86)
10	27	(15.74)	41	(24.21)	34	(20.37)	48	(28.33)	19	(11.35)	168	(102.35)

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